Marine Fisheries
REVIEW

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

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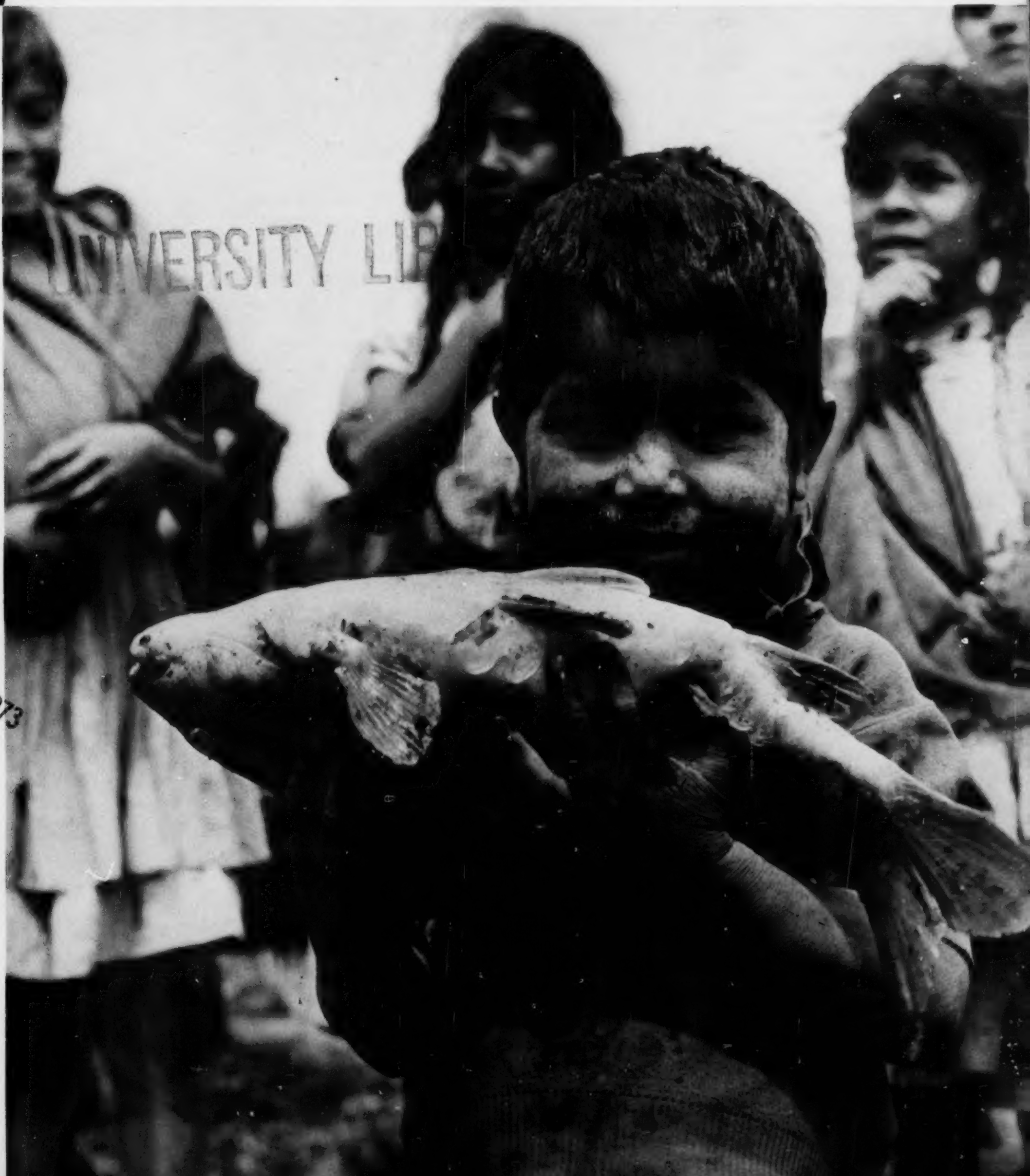

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Marine Fisheries REVIEW

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FRONT COVER: Mexican boy holds the winner. Photo by R. Moya. Courtesy of TECNICA PESQUERA magazine.

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OF SPORT FISHING AND FISHERMEN

Laura Burchard

Fishermen, as everyone knows, come in all sizes--little fry with 10-cent hooks to tired executives with expensive gear complete with boat. But what conservation agencies want to know is who they are, where they fish, how much they fish, and how much they spend on the sport.

To find answers, the U.S. Government supplied Federal aid funds for an extensive updating of previous surveys.

The 1970 National Survey of Fishing and Hunting, conducted by the Bureau of the Census and released recently, shows an increase in avid fishermen despite pollution, mercury, dredging, urbanization, and changing occupations and interests of young people. During the year, about 49 million Americans fished at some time or another--averaging one in every 3 men, and one in every 9 women.

The fishermen come from a wide range of social, economic, and demographic backgrounds. By education, the group with the highest number of fishermen was the high-school graduates. In occupation, the largest single group was the blue-collar craftsmen; farm laborers and household workers were the smallest. Among white-collar workers, professionals and technicians made up the largest group. But the very lowest number recorded was in the group one might think had the most time for "bathing a worm", the 'Never Work Fulltime' category.

The largest group by age was the 45 to 64 bracket; the lowest, teen age. But a new group is coming on--the 9-to 11-year olds; $3\frac{1}{2}$ million boys went fishing, and almost 2 million girls followed their lead.

The Biggest Fish Story

Based on family income, the largest group was the 10-to 15-thousand-dollar class. In fact, this income bracket led in number of fishermen and in all statistics. They spent the most money--over a billion dollars--and took the most fishing trips, traveled the most miles, and enjoyed the most recreation days.

There are some fishermen among those cowboys out west. The highest percent (per population) of fishermen is in the western mountain states, with the northern part of the midwest next. Towns and rural areas, of course, led the way, but a surprising 12.3% of urban dwellers escape the city with rod and reel.

Where they fished naturally followed geographic location. Anglers tended to ply the 'fishing hole' in their own area. The survey indicates more either fished less than a mile from home, or traveled 100 to 250 miles. There were, however, over 40,000 fishermen who covered 4 or more states in their pursuit of the "big ones". Totals show that modern-day Isaac Waltons added up more than 29 billion passenger-miles in search of fish.

Who Is Minding The Store?

In 1970, American fishermen spent 706,187,000 recreation days at the sport. Over 29 million of them tried their luck during 592 million days of fresh-water fishing, and about a third that many fishermen used more than 113 million days on the briny deep. They spent close to 5 billion dollars--over 30 million dollars of this amount just launching their boats.

Simpler Arithmetic

Here are some figures easier to fathom: Fishermen, seeming to prefer their sport alone and unorganized, averaged only \$.24 on special club dues. They spent, on an average, less than a quarter on guide fees, and a mere nickle for special government fees. You can draw your own conclusions on their luck when you note they spent more feeding the fish than themselves--averaging \$17.11 on bait and \$14.41 on meals.

Twenty-million-plus fishermen were licensed in 1970. These fees, sales excise taxes on equipment, and contributions to conservation organizations mean that, for the most part, fishermen pay their own way. General taxes have not been a major source of funds for maintaining fish and wildlife resources.

These figures are more than comparative statistics. They represent facts that may determine where and how we all will fish in

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Mrs. Burchard is Assistant Editor of Marine Fisheries Review.

Expenditures of Fishermen in 1970

Expenditure item	Number of spenders	Percent of all fishermen	Total spent	Average spent per fisherman
	Thousands		*Thousands*	
United States, total	31,407	94.7	$4,958,883	$149.55
Food and lodging:				
Food	15,352	46.3	477,720	14.41
Lodging	3,795	11.4	166,928	5.03
Transportation:				
Automobile	25,462	76.8	613,742	18.51
Bus, rail, air, and water	304	.9	25,000	.75
Auxiliary equipment:				
Special fishing clothing	1,000	3.0	14,441	.44
Tents	411	1.2	19,400	.58
Boats	890	2.7	472,147	14.24
Motors	792	2.4	224,226	6 76
Other equipment	6,299	19.0	753,171	22.71
Fishing equipment:				
Fresh-water rods	6,211	18.7	87,461	2,64
Fresh-water reels	5,109	15.4	80,617	2.43
Salt-water rods	1,194	3.6	24,747	.75
Salt-water reels	969	2.9	27,474	.83
Lures	10,666	32.2	84,488	2.55
Lines	9,497	28.6	37,907	1.14
Other fishing equipment	15,018	45.3	126,455	3.81
Licenses, tags, and permits:				
Licenses	19,874	59.9	108,839	3.28
Privilege fees and other:				
Annual lease and privilege fees	361	1.1	24,637	.74
Daily entrance and privilege fees for fishing	2,435	7.3	61,042	1.84
Special government fees	186	.6	1,740	.05
Bait, guide fees, and other trip expenses:				
Bait	19,176	57.8	567,235	17.11
Guide fees	160	.5	7,942	.24
Head and charter fees	2,156	6.5	130,738	3.94
Alcoholic beverages	6,127	18.5	223,857	6.75
Rental equipment	4,401	13.3	119,217	3.59
Other trip expenses	9,641	29.1	340,700	10.27
Magazines	5,291	16.0	36,356	1.10
General club dues	930	2.8	33,251	1.00
Special club dues	317	1.0	7,855	.24
Boat launching fees	1,762	5.3	30,276	.91
Other	2,296	6.9	29,276	.88

The National Survey of Fishing & Hunting was done in 2 parts: part 1, by mail, including anyone who fished in 1970; part 2, by personal interviews with active fishermen. Findings in part 2 were used for this table.

the future. They are imperative to good management of our natural resources. Their very size and volume support the necessity for such a survey.

Our burgeoning population will surely call for proliferation of leisure-activity services. Business communities will continue to develop in areas where personnel have access to recreation. How can we grow and not outgrow our fishing and recreation resources?

This question is really the "big one". Our government and private conservation agencies do not plan to let it get away. They will use the information gleaned in this survey to improve planning in restoration, management, and research.

Keeping Figures in Shape

The conservation agencies need, and the changing nature of our fisheries makes it imperative, to recheck the facts periodically. This survey is the fourth in a series requested by The International Association of Game, Fish, and Conservation Commissioners, which represents the states and Canadian Provinces. Surveys are done in 5-year intervals. So too will be the National Marine Fisheries Service collection of statistics on Marine Sport Fisheries (See Marine Fisheries Review, Sept.-Oct. 1972).

Anyone interested in the complete survey in paperback form may order it for $1.25 from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

U.S. & JAPAN RENEGOTIATE 2 NORTH PACIFIC FISHING AGREEMENTS

The U.S. & Japan have renegotiated two fishery agreements dealing primarily with the northeastern Pacific Ocean and the Bering Sea.

One fishing agreement, first signed in 1967, provides that Japan will continue to refrain from fishing within the nine-mile contiguous U.S. fishery zone. The exceptions will be selected areas mainly off the Aleutian Islands.

In return for fishing privileges within the U. S. contiguous zone, the Japanese have agreed not to fish in certain high-seas areas off Alaska during certain seasons. This will avoid conflicts with U.S. fishermen that arise from the use of different type gear.

Major changes in the renegotiation of this fishing agreement involve the seasons when Japan will be allowed to fish both inside and outside the 12-mile limit adjacent to the U.S. coast. Japan was given new privileges to use the fishery zone contiguous with the Aleutian Islands for loading and unloading fish and supplies.

King and Tanner Crab

The second agreement concerns king and tanner crab in the Bering Sea. This fishery is important to both the U.S. and Japan. In recent years, the U.S. fishery has expanded appreciably. Japanese fishing for these species will be reduced about 70% in the southeastern Bering Sea. However, Japan will continue to develop a crab fishery north and west of the Pribilof Islands, an area not used by the U.S. This will give U.S. fishermen greater control of king and tanner crab resources in the southeastern Bering Sea. The U.S. claims these resources because they are "creatures of the shelf" under the 1958 Continental Shelf Convention.

Increased Enforcement

Both nations will have increased opportunities to observe the conduct of enforcement of agreement provisions. The U.S. will have better observation of fishing operations. Both acknowledge, too, the need to avoid polluting these waters and the dumping of undesirable products from fishing vessels.

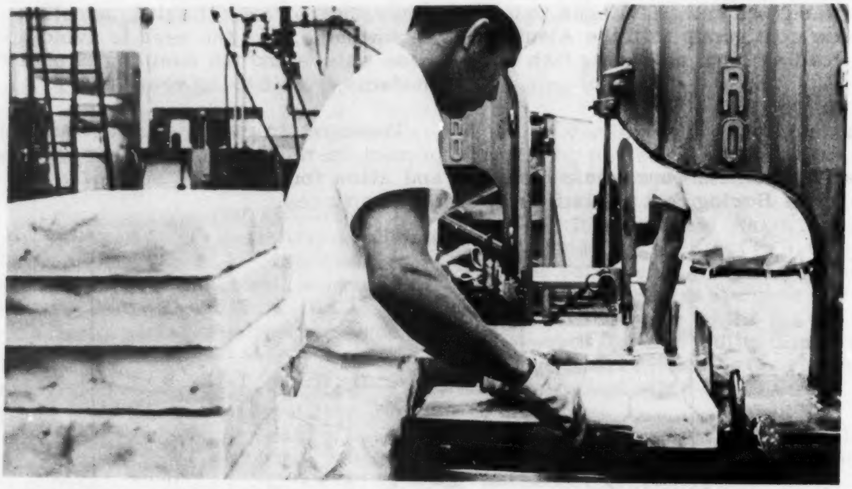
These newly established agreements will protect the northeastern Pacific environment and allow for better conservation and use of the resources.

THE 1972 FISHERY PRODUCT SITUATION

The supply of fishery products improved in 1972. This was due largely to much greater imports. Per-capita consumption is estimated up 0.2 pound; fresh and frozen and canned products share the increase.

Consumption of some species--haddock and sea scallops, for example--was reduced. This is attributed mainly to diminished world supplies and growing foreign demand. Shellfish supplies were up slightly--mainly because of a substantial increase in shrimp. In January-August, shrimp landings rose 8% and imports 26% above a year earlier.

were 33% ahead of the year-earlier period. There is a wide price spread between lower-priced blocks--ocean perch and pollock, for example--and higher-priced flounder. Cod, the largest proportion of block imports, is also relatively high priced. Imports of the lower-priced species have been increasing as a percentage of the total; they offer a less-expensive product in a period of rising prices. The output of products, restricted by the shortage of blocks in 1971, increased 15% through first-half 1972 over a year earlier. Inventories of blocks were up 35%.



Production of breaded fish portions. A series of cuts with high-speed saws turns blocks into uniform portions desired.

Groundfish

New England groundfish landings slipped below 1971. Cod and haddock landings fell substantially--while flounder and ocean perch landings increased. Imports of all groundfish except haddock rose over 1971.

Frozen Blocks

Through October 1972, imports of frozen blocks, used to make sticks and portions,

Canned Fishery Products

The supply of canned fishery products rose. Tuna and sardines are much higher, so total production is estimated up 6% in 1972. Salmon production will be extremely poor. It is down 43% from 1971 and 36% below level of last 5 years.

PINK-SALMON STOCKS RESTORED TO ALASKAN STREAM

Ten years ago, biologists counted 8 pink salmon in Sashin Creek on remote Baranof Island in southeast Alaska. In August-September 1972, 14,000 adult pink salmon--1,750% more--were observed returning to spawn. The restoration crowned 8 years of experimentation by biologists of NMFS Biological Laboratory in Auke Bay to reestablish once-productive runs by transplanting adult fish.

In the 1950s, biologists assessed many Alaskan spawning streams. They reported that heavy exploitation and high natural mortality had hurt the once-abundant and valuable pink-salmon stocks. As early as 1948, Sashin Creek was added to the growing number of depleted runs. Only 597 adult pink salmon were counted in the creek; in 1942, there had been 92,000 fish.

Restoration Experiments Begun

Federal and State biologists initiated experiments to restore Sashin's depleted runs by transplanting adult salmon from another stream. In 1964, 2,000 adult pink salmon were captured alive by a commercial seiner and placed in holding tanks aboard a cannery tender. Then they were carried 50 miles to Sashin Creek and released above a weir emplaced to prevent their return to the home stream.

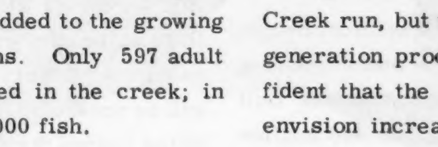
The transplanted salmon adjusted readily. In the first year, the survival rate was a better-than-average 13% of spawned eggs. The salmon fry migrated to sea during spring 1965--and 6,000 returned as adults in summer 1966 to produce new generations.

12,000 in 1968

By 1968, the run had increased to 12,000 adults. The run cheered the experimenters because earlier attempts to stock barren Canadian and Soviet streams with pink salmon eggs and fry from hatcheries had failed after initial successes. In 1970, there was a slight drop to 10,000 fish in the Sashin Creek run, but this did not interrupt the regeneration process. Researchers are confident that the run is reestablished. They envision increases to 30,000 spawners, the most Sashun now can accommodate.

State Programs

Alaska's Department of Fish and Game has transplanted pink salmon to rehabilitate fish runs to Prince William Sound. These were hit hard by the severe earthquake of 1964. State biologists have identified streams that once boasted goods runs of pink salmon. These will be stocked with spawners from streams that have surpluses.



Pink Salmon

CATCH BY U.S. SALTWATER ANGLERS INCREASES

The catch by U.S. saltwater anglers during 1970 was 817 million fish weighing 1.58 billion pounds, according to preliminary data from the 1970 Saltwater Angling Survey. The survey was conducted for the National Marine Fisheries Service by the Bureau of the Census as a supplement to the 1970 National Survey of Fishing and Hunting.

The 1970 catch was up 11% in number of fish and 7% in weight landed since 1965. A similar survey then showed 737 million fish caught weighing 1.47 billion pounds. From 1965 to 1970, the number of saltwater anglers increased from 8.2 million to 9.4 million.

Which Fish & Where Caught

Atlantic Coast anglers (5.0 million) caught 469 million fish, or 918 million pounds, during 1970. The 2.3 million anglers on the Gulf Coast hooked 287 million fish, or 486 million pounds. On the Pacific Coast, 2.1 million anglers caught 61 million fish, or 173 million pounds.

Sea trouts led in numbers (107 million fish) and weight (153 million pounds). Croakers were second in number (66 million), followed by flat fishes (57 million), catfishes (56 million), and Atlantic mackerel (52 million).

Bluefish ranked second in weight (121 million pounds), followed by flat fishes (93 million pounds), striped bass (84 million pounds), and croakers (75 million pounds).

Detailed Results in 1973

Detailed results of the 1970 Saltwater Angling Survey will be published in early 1973. Data on the number and weight of each species caught by fishing method and area of fishing will be presented for seven geographical areas of the United States.

SPORTFISHING '73 FORUM & EXPO

A discussion and exposition of saltwater sport fishing will be held at the Ocean City (Md.) Convention Hall, April 7 and 8, 1973. It is sponsored by the National Marine Fisheries Service, the Delmarva Advisory Council, and natural resource conservation agencies of Delaware, Maryland, Virginia (these 3 are Delmarva), and New Jersey.

Sport fishermen and others interested in ocean resources are invited to panel discussions on the how, when and where of fishing for fun, and the more serious discussions of problems facing sport fisheries. Scientists, economists, managers, environmentalists, and local fishing experts will be evaluating the potential of the 4-state-area sportfishing resources. They hope these exchanges will provide some direction for future management plans as to fishing limits and conservation of stocks.

Of added interest will be the many exhibits and demonstrations of the latest fishing tackle, boats, and other outdoor equipment.

NEWEST NMFS PUBLICATIONS: FISHERY FACTS

The newest publications of the National Marine Fisheries Service are the first 4 booklets in the series titled "Fishery Facts". The series is valuable to fishermen, processors, and biologists. It documents research developments in the fishery sciences, including biology, technology, and engineering. Information for Fishery Facts is drawn from the NMFS staff.

Fishery Facts I is Redfish--habitat, catch and market demand. No. 2 looks at Alaska's Pacific Herring. Dungeness Crab Pots, their design and use, are examined in No. 3. Fishery Facts 4 deals with Inshore Lobster Fishing, the various pots, methods, equipment, bait, costs, and regulations. All these 6-by 9-inch booklets have pictures and illustrations.

The booklets are available for 25 cents each from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

NMFS SURVEYS READERS OF ITS MARKET NEWS REPORTS

A study to determine how well the Fishery Market News Reports fill the needs of their users has been completed by the Statistics and Market News Division of the National Marine Fisheries Service. The Market News Reports are issued three days a week by the seven Market News offices in important fishing and distribution centers.

During April 1972, a questionnaire was sent to the more than 10,000 readers in the United States and in 70 foreign countries. Questions covered the kinds of market information readers want, how often they want the information, how the information is used, the occupations of readers, and whether they would be willing to pay for the reports.

What Readers Want

The returned questionnaires reveal that most subscribers are interested primarily in wholesale prices of fresh fishery products, landings, wholesale prices of frozen fishery products, imports, miscellaneous news items, and items about U.S. Congressional actions, in that order. More fishermen, wholesalers, and buyers ranked wholesale prices of fresh fishery products as important to them; while processors, importers, and brokers rated wholesale prices of frozen products of prime importance.

Regional Differences

A number of regional differences were noted. For example, readers of reports from the Market News offices in fish-landings centers, such as Boston, Seattle, Terminal Island (California), New Orleans, and New York City, ranked landings and wholesale prices of fresh or frozen products as most important, but not necessarily in the same order of importance. Terminal Island subscribers ranked information about imports most important, and Chicago readers rated cold-storage holdings third in importance after wholesale prices for fresh and frozen products. Only Hampton, Virginia, readers included Congressional actions in the top three.

Readers were asked to list by priority the kinds of information they wanted in a Market News Report. Landings information ranked first and prices second in both the first and second priority category. Data on imports and cold-storage holdings were given top ranking in the third and fourth categories, respectively.

Readers were asked to record how often they desired to receive the information in the various sections of the Reports. The results indicate that some subscribers appear to need market information daily--but the majority would prefer most sections issued once a week. The three-times-a-week group were second in number, then five-times-a-week and, lastly, people who would like to receive sections of the report twice a week.

88% Would Pay Postage Equivalent

Although most readers (88% of respondents to this question) stated they were willing to pay a fee equivalent to the cost of postage to continue getting the reports, two of three preferred less frequent mailing. Greater numbers of fishermen, wholesalers, retailers, and buyers preferred to pay for the reports rather than have the number of mailings per week reduced.

Almost four of five readers shared the Market News Reports with others; the number of additional readers ranged from two to several hundred. The most frequent use made of the data in the reports is for management decision making.

The survey results indicate that readers of Market News Reports are generally satisfied with the information provided and find most sections useful. Nevertheless, based on analysis of questionnaire results, recommendations for some changes will be made and carried out in Market News Offices. This is part of the Statistics and Market News Division's continuing efforts to provide most efficiently the data users want, and to improve the Division's overall operations.

THE ATLANTIC SALMON: Questions & Answers

A. W. May

1. What is the basic Canadian attitude toward fishing of Atlantic salmon?

   As with any other species, we believe that salmon should be fished in accordance with their productive capacity--that is, they should be fished to the maximum extent possible leaving an adequate spawning stock.

2. Where are the salmon being fished now?

   All along the Canadian Atlantic coast from Labrador to the Bay of Fundy, and also at Greenland.

3. How do we know that salmon at Greenland come from Canada?

   Primarily through tagging of young salmon when they first migrate to sea. Over the past 10 years many hundreds of tagged fish have turned up in Greenland.

4. Do all the fish in Greenland originate in Canada?

   No, but on the basis of tagging, plus analysis of blood samples, we estimate that roughly half the salmon present originate in Canadian rivers. A small proportion comes from the United States, and the remainder from western Europe, mainly the U.K. and Ireland.

5. Are there no salmon rivers at Greenland?

   There is only one known river that contains salmon, a small stream with a run of no more than a few hundred fish.

6. Do all Canadian salmon go to Greenland?

   No, only those fish which spend 2 years in the sea before returning to spawn. Fish that return after 1 year (grilse) are not fished at Greenland.

7. Are the 2-sea-year fish evenly distributed among Canadian rivers?

   Again no. Rivers that flow into the Gulf of St. Lawrence, and these are mainly Quebec and New Brunswick rivers, have larger proportions of 2-sea-year fish in the runs than do rivers in Labrador and Newfoundland, for example.

8. Does this mean that fisheries at Greenland have different effects on salmon stocks from different rivers?

   Very definitely so. All Canadian rivers probably contribute some salmon to Greenland; the contribution of some is small in relation to the rivers stocks, but the contribution of others is very large. Apart from that, all fish that go to Greenland are destined to be large 2- or 3-year fish. These are the most valuable commercially, to the angler and for reproduction; 75% of the salmon caught at Greenland are <u>females</u>.

9. Do we have any figures on the numbers of salmon at Greenland which come from different rivers?

   We cannot be that precise, but we do have information on a relative basis. In a number of cases, this shows that the contribution to Greenland must be high. The most notable example is a Quebec tagging experiment where tagged fish were released in 4 different rivers. Of all the tags returned, 42% came from Greenland. This, incidentally, would be a minimum figure because some fishermen at Greenland do not report tags they find.

10. How do we know that fish come back from Greenland to Canadian rivers?

    Salmon have a very strong homing instinct. Almost invariably, they return to the stream in which they were born when they are ready to spawn. It is inconceivable that, each year, hundreds of thousands of salmon would find their way to Greenland, grow larger, and then would not be able to find the way back.

Dr. May, a Canadian scientist, has much experience with Atlantic salmon--particularly in relation to the Greenland and highseas fishery. He prepared these questions and answers for the International Atlantic Salmon Foundation.

In fact, a few hundred fish have been tagged at Greenland in each of the past 5 or 6 years. A total of 27 tags has been recovered outside of Greenland; 12 in Canada, and 15 in Europe. Other tagging experiments have been carried out in the middle of the Labrador Sea after the fish have left Greenland. All returns from these experiments have been to Canadian waters within a few months after tagging. The returns from Greenland are small, probably because of a high mortality of fish tagged from drift nets in the ocean.

Another piece of evidence points to the strong homing instinct of salmon, even from as far away as Greenland: No salmon tagged in North America has ever been recaptured in Europe, or vice versa. Hundreds of thousands of juvenile fish have been tagged on each side of the Atlantic, and salmon from each side occur together at Greenland. If their homeward migration were not directed, we would expect some fish to become lost and to occur on the other side of the Atlantic. We have no evidence that this has ever occurred.

11. Wouldn't some salmon be eaten by larger fish or other animals on the way back?

Some would, but there are not many animals capable of catching an 8-pound salmon. In fact, a very great mortality of salmon in the sea does occur; however, scientists agree that most of this must take place soon after the young salmon leave the rivers for the first time, when they are only 6 inches long. We have no figures for losses during the migration from Greenland to home waters. But, considering the size of the salmon and the time interval involved, losses must be small in relation to those that occur in early life.

Therefore, we believe that these large salmon would return to Canada in large numbers if not taken at Greenland.

12. How severe are the effects of Greenland fishing?

Quite severe on our fisheries. Every fish caught at Greenland is, potentially, one less available to Canadian fishermen. However, the effect on spawning stocks is selective: it is greater in some rivers than others. In a few of our major rivers, the combination of fishing at Greenland, plus fishing in and near the rivers, has contributed to a serious decline in spawning stocks. This is so serious that we are concerned about the continued existence of salmon in those rivers.

13. Is this the reason for closures of fishing in some areas?

Yes, with the exception of the St. John River, where declines have been due to local factors.

14. How big a part has pollution played in causing declines in our rivers?

Declines in some of our large rivers about 15-20 years ago undoubtedly were associated with such factors as increasing pollution, plus poor forest-spraying practices. A great deal of progress has been made in alleviating these conditions, yet salmon runs continue to decline. In 1971, in spite of continuing Canadian fisheries at a high level, catches in some areas were the lowest in 100 years of recorded statistics.

15. Are there natural fluctuations in salmon abundance?

Natural, cyclic fluctuations occur. Salmon abundance was increasing in the early 1960s. It reached a peak in 1967, but this peak was far below previous peaks associated with natural fluctuations. The decline in the Maritimes and Quebec since 1967 has been more rapid than anything we have ever seen before.

16. If half the Greenland catch is Canadian salmon, what does this amount to in relation to the Canadian catch?

In 1971, the Canadian contribution to Greenland fisheries was about 1300 tons, or about 400,000 fish. These were the large 2-sea-year salmon so important to our own fisheries and spawning stocks. We believe that most of these fish originated in Quebec and New Brunswick streams. The fisheries in these areas took less than 400 tons last year, or less than 100,000 fish of the 2-sea-year group. It is obvious that the areas producing these fish are not reaping the benefits of this production.

17. Most of the Canadian catch is taken in Newfoundland and Labrador. What is the situation there?

The catch in these areas has remained at a relatively high level in recent years. A large proportion of the catch consists of grilse (one-sea-year fish). Newfoundland rivers contain mainly grilse in the spawning runs. Interception of salmon bound for mainland rivers does occur, but the extent is unknown. We do not know what proportion of the salmon taken in Newfoundland is bound for mainland rivers.

EXPERIMENTAL ATLANTIC SALMON HATCHERY PLANNED

A $2.4 million experimental selective breeding hatchery, designed to produce high-quality hybrid strains of Atlantic salmon, will be built by several cooperating Canadian and U.S. agencies. "The objective is to enhance, rehabilitate, and establish salmon runs in Canadian and New England rivers."

The hatchery is expected to be under construction early in 1973 on Chamcook Creek, about 3 miles east of St. Andrews. It will be operational by 1974.

The participants include the Canadian and U.S. governments, the International Atlantic Salmon Foundation (a privately sponsored research and education foundation), the Huntsman Marine Laboratory (a consortium of universities and other agencies promoting teaching in the marine sciences), and the State of Maine.

The Plan

The hybrid strains will be developed from brood salmon selected from the Northwest Miramichi River in New Brunswick and a nearby river in Maine. The experimental hatchery is expected to produce annually about 300,000 one-year-old smolt salmon. About 135,000 of these will be released in the test rivers in New Brunswick and Maine. The remainder will be retained in the hatchery to develop the selective breeding program.

As desirable traits are acquired by the salmon through selective breeding procedures, populations will be released through production hatcheries to reestablish stocks in rivers that have lost their runs, strengthen existing populations, and establish populations in streams that never had them.

The planners say the selective breeding programs to be undertaken by the experimental hatchery do not lessen the necessity of programs to restore river conditions so that natural reproduction of Atlantic salmon will be enhanced. However, they add, some salmon rivers may never be restored to the best environmental quality levels. Because existing salmon stocks also have been seriously depleted by overfishing, natural reproduction alone cannot be relied on to maintain the North American Atlantic salmon resource.

The planners emphasize that this serious situation indicates the need for immediate use of specialized resource development and management techniques. One of these is the experimental hatchery research program.

A Correction

Marine Fisheries Review, July-Aug., 1972, page 2, stated: "Canada catches about 95% of the North American Atlantic salmon taken off Greenland." "Catches" should be replaced by "produces".--Ed.

INITIAL SUCCESS IN ESTIMATING REARING-POND SHRIMP POPULATION

K. N. Baxter

In late 1971, Galveston Laboratory personnel of the National Marine Fisheries Service estimated shrimp-population size in four ½-acre ponds at Texas A&M's field research site near Angleton, Texas. The estimates were needed to determine shrimp-feeding rates. The lab did this at the request of Texas A&M University's Sea Grant Mariculture Program.

Shrimp from four ponds were injected with a fluorescent pigment-petrolatum mixture. Marked shrimp were returned to the ponds. Then samples of shrimp were collected from each pond for population-size estimates according to the Petersen method. Then the ponds were drained and all shrimp counted. Estimates were within an average of 20% of the actual number of shrimp recovered after draining. The following table shows results obtained in the pond experiments:

		Population size		
Pond	Number Marked	Estimated	Actual	Difference in percent of actual population size
A	1,210	7,798	6,644	17
B	1,820	14,970	11,469	30
C	1,000	5,978	5,050	18
D	1,200	3,957	4,049	2
Combined	5,230	32,701	27,212	20

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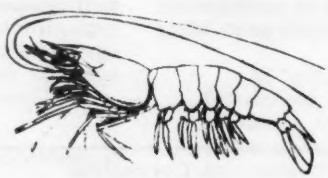


SOUTHERN RIGHT WHALES DISCOVERED OFF ARGENTINA

U.S. Navy researchers aboard the 'Hero' off Argentina recently discovered an extensive population of the rare southern right whales (Balaena glacialis australis) in the near-shore waters off Punta Rosa, about 200 miles north of Golfo San José. Before, it was thought the distribution of these whales ended at San Jose.

This was reported by Dr. William C. Summings and Dr. James F. Fish of the U. S. Naval Undersea Research and Development Center (NUC). They traveled aboard the National Science Foundation's Hero.

The scientists said the sighting of about 35 southern right whales "could easily represent an increase of the Argentine population by 30 to 50%." Previously, the only known breeding ground was near Golfo San José.

It is believed that overfishing has brought the right whale to its present status of endangered species.

The Research Cruise

During the trip, Aug. 4-25, 1972, Dr. Cummings, Dr. Fish and Paul O. Thompson, all of NUC, found that this whale produced the most numerous and diverse underwater sounds during courtship. At other times, it rarely made sounds.

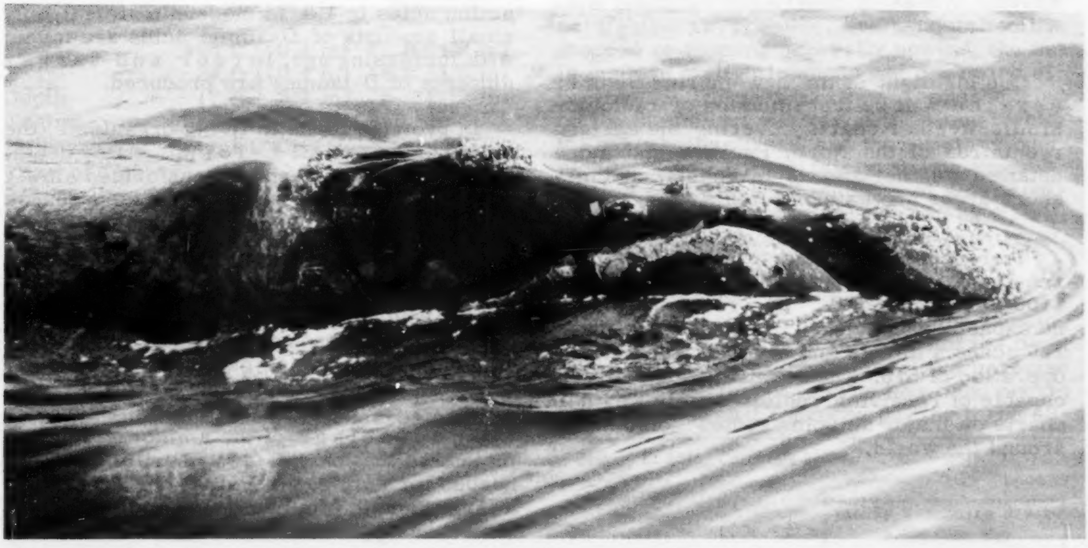
During breeding periods, the whales frequently were in threesomes--presumably two males and one female. This behavior duplicates the habits of the gray whale observed in Scammon's lagoon in Baja California.

The researchers sighted baby southern right whales in the breeding areas. They said it was the first evidence that the whales not only courted, but also gave birth, there.

Whale Migrations

The researchers said the Argentine population of southern right whales is believed to make a 4,000-mile migration to and from Antarctica every year. Gray whales migrate from Mexican waters past Point Loma on their trip to and from the Arctic.

The adult southern right whale averages 55 feet in length. It has an enormous head, about one-third as long as the rest of the body. It has no dorsal fin.



Hippopotamus? No. It is the southern right whale, about 60 feet long, photographed in the breeding grounds off Argentina. The head region shown here has horny growths. The most characteristic feature of the right whale is the terminal growth, called 'bonnet', on its snout. (Official Photo U. S. Navy)

NEW WEATHER SERVICE IN 1973 FOR PACIFIC DEEP-WATER SAILORS

The National Weather Service and the U.S. Coast Guard announced in November 1972 that a new marine weather service for deep-water sailors in the Pacific would begin in February 1973. The agencies were giving mariners ample time to get the radiofacsimile equipment needed to take full advantage of the new service.

The service will consist of up to 8 hours a day of forecasts and warnings transmitted by Morse telegraphy, voice, and radiofacsimile from the new Coast Guard radio station at Point Reyes, about 35 miles northwest of San Francisco. The transmissions will provide the first large-scale forecast and warning services designed especially for commercial shipping and fishing in the eastern North Pacific.

Around the Clock

The two agencies stated: "The transmissions will be made around the clock at frequent intervals timed to coincide with shipboard watch schedules in the North Pacific. Primary emphasis will be on predictions and warnings of storms, high winds, and waves. Areas of restricted visibility also will be emphasized."

One highlight of the new marine weather service will be transmission of radiofacsimile weather charts covering the eastern two thirds of the North Pacific--and more detailed weather charts of coastal and offshore areas of western North America.

To receive these charts, radiofacsimile receivers will be needed. These rent for \$100 to \$250 a month. The receivers should be capable of copying a transmission rate of 120 scans a minute and have an index of cooperation of 576. The receivers also will be capable of receiving radiofacsimile weather charts on major shipping routes "elsewhere around the world."

HOW TO TELL A MULTIMILLION-YEAR SHARK VERTEBRA

A shark's vertebra found in a manganese nodule recovered on the ocean floor west of Hawaii has been dated at 8.7 million years by Dr. Jeffrey Bada of the Scripps Institution of Oceanography. He used a new dating method he developed based on amino acids. The nodule had been dredged up in August 1970 from the submerged Horizon Guyot by the Scripps research vessel 'Thomas Washington'.

Dr. Bada has disclosed research he uses to date bones older than 30-40,000 years. These bones are too old to be dated by using carbon-14. Before his finding, there had been a void between dating bones too old for radiocarbon (carbon-14) techniques and too young for other chronological dating methods.

Dr. Bada uses a process called racemization of amino acids, which he initiated in 1970. Amino acids are the molecules that make up the proteins in living organisms. Amino acids can have two optical forms--the L- and D-isomers. Only the L-amino acids are found in living systems.

Over long periods of geological time, L-amino acids produced originally by living organisms undergo conversion to D-isomer. This process continues until ratio of L to D amino acids is 1.0. In modern material, only small amounts of D-amino acids are found; with increasing age, larger and larger amounts of D-isomer are produced.

In proteins found in living organisms, the amino acids are all L-form. After death, however, this pattern is transformed slowly by the racemization process, which produces the D-form. By measuring ratio of D to L forms, the bone's age can be estimated. The greater the proportion of D-isomer in amino acids, the older the bone. To determine the amino acid age, the environment's temperature must be known, and this temperature should not have varied greatly since the time the bone was deposited.

An advantage of the amino-acid dating method is that only a few grams of bone are needed for dating; for radiocarbon analysis, a large sample of a bone (in pound quantities) is necessary.

REMOVING PORPOISE FROM A TUNA PURSE SEINE

James Coe and George Sousa

Between 50 and 70% of the annual U.S. catch of yellowfin tuna in the eastern tropical Pacific comes from schools associated with porpoise (unpublished data, Inter-American Tropical Tuna Commission). Tuna primarily associate with two species, the so-called "spotters" and "spinners." At times, they may be found in the company of a third species, which fishermen call "whitebellies" (Perrin, 1968, 1969, 1970; Green, Perrin and Petrich, 1971). Once the seine has been set and pursed around a school of porpoise and the associated tuna, the problem arises of releasing the porpoise unharmed without losing the fish.

In the interest of disseminating information that will contribute to conservation of the porpoise stocks, this paper presents a detailed account of the equipment and methods used by one seiner that has attained a high degree of success in removing porpoise from its net.

VESSEL AND EQUIPMENT

The specifications of the vessel and its net skiff follow:

	Vessel	Net skiff
Length	165 ft (50.4 m)	31 ft (9.5 m)
Beam	34 ft (10.4 m)	18 ft (5.5 m)
Depth	17 ft (5.2 m)	5 ft (1.5 m)
Engine	2800 hp	250 hp
Hull	Steel	Steel
Year of construction	1970	1970
Brine well capacity	650 short tons	-

The main purse winch on this vessel was a Marco model 1072 built by the Marco Corporation, Seattle, Washington. It was driven by a 333 hp Caterpiller diesel engine coupled to a Vickers hydraulic system providing 1500 psi at 70 gallons per minute. The Marco 42-inch diameter power block was integrated into the same hydraulic system.

The Net

The net used by this seiner was hung 570 fathoms long and about 52 fathoms deep in 1970; since then, it has shrunk to approximately 540 fathoms by 48 fathoms. The basic construction was described by McNeely in 1961--with the exceptions that the net was nine strips deep, and the bunt sections at the bunt end and at the single cutting strip at half net were made with number 96 twine. This net lacked the Medina escape panel of 2-inch webbing to prevent porpoise entanglement, which is currently being adopted by many boats in the U.S. fleet.

METHODS

The technology of tuna purse seining in general and "porpoise-fishing" in particular has previously been described (Green, et al., 1971). The following pertains to details of operation that bear on efficiency in removing porpoise from the net alive.

When the porpoise school has been bunched as tightly as possible, and the school is stopped or running generally upwind, the set is made in a slightly cross and downwind direction. Setting in this manner keeps the wind on the stern port quarter of the vessel while the net is being pursed, and the net stays open nicely. Even with a fairly strong current, setting with the wind on the port side, combined with the pulling of the net skiff, will usually keep the boat from drifting into the net.

While the net is being pursed, there is a tendency for the slack corkline and webbing to wrap around the bow and stern of the boat. This forms bags or pockets where porpoise may become trapped. The bow bend pocket is eliminated as it forms by pulling three 40-

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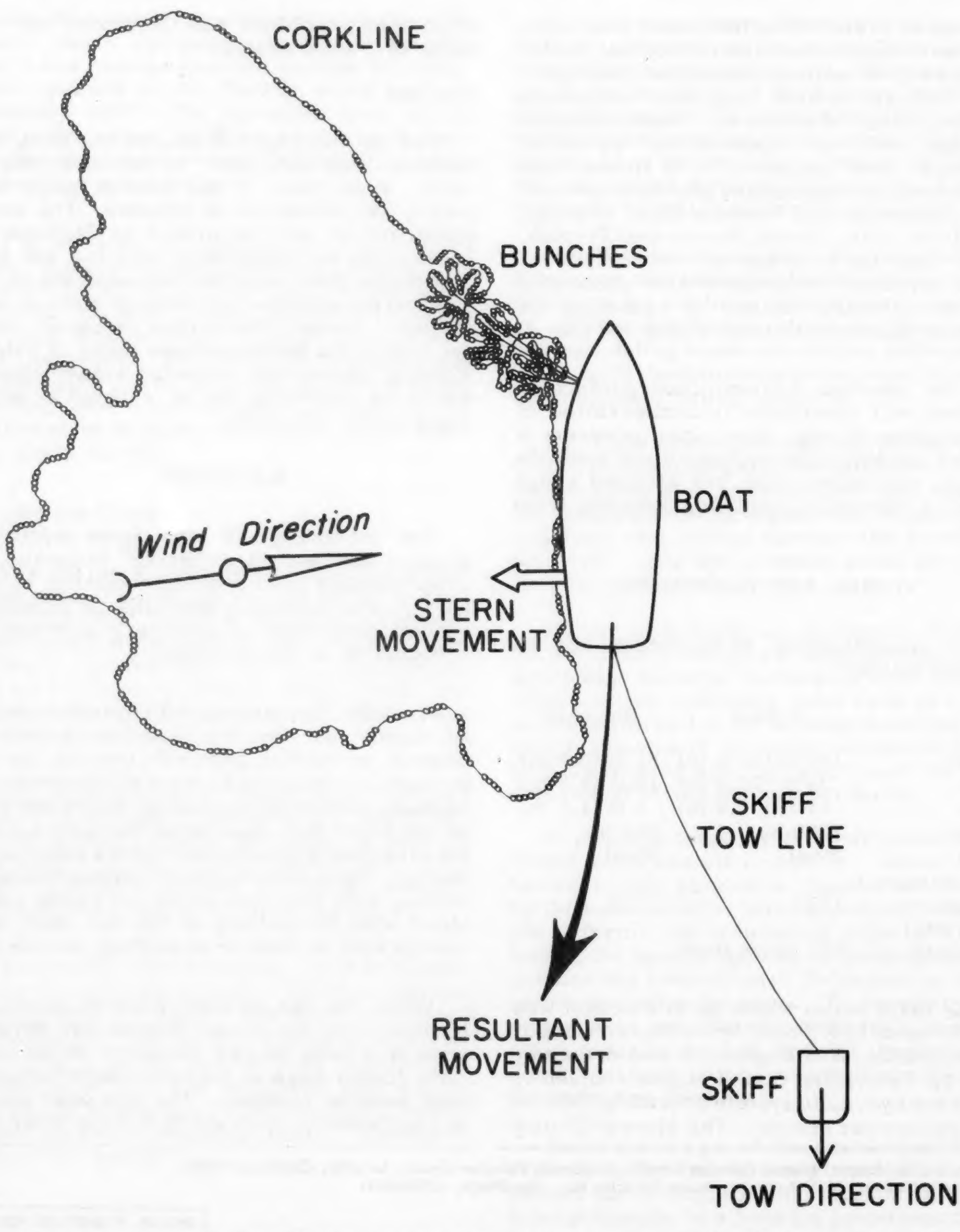

Fig. 1 Rolling net causes the stern of the boat to move into the net (double arrow) so that the skiff tows parallel to the axis of the boat, and the resulting movement is backward in a large clockwise semicircle (solid black arrow).

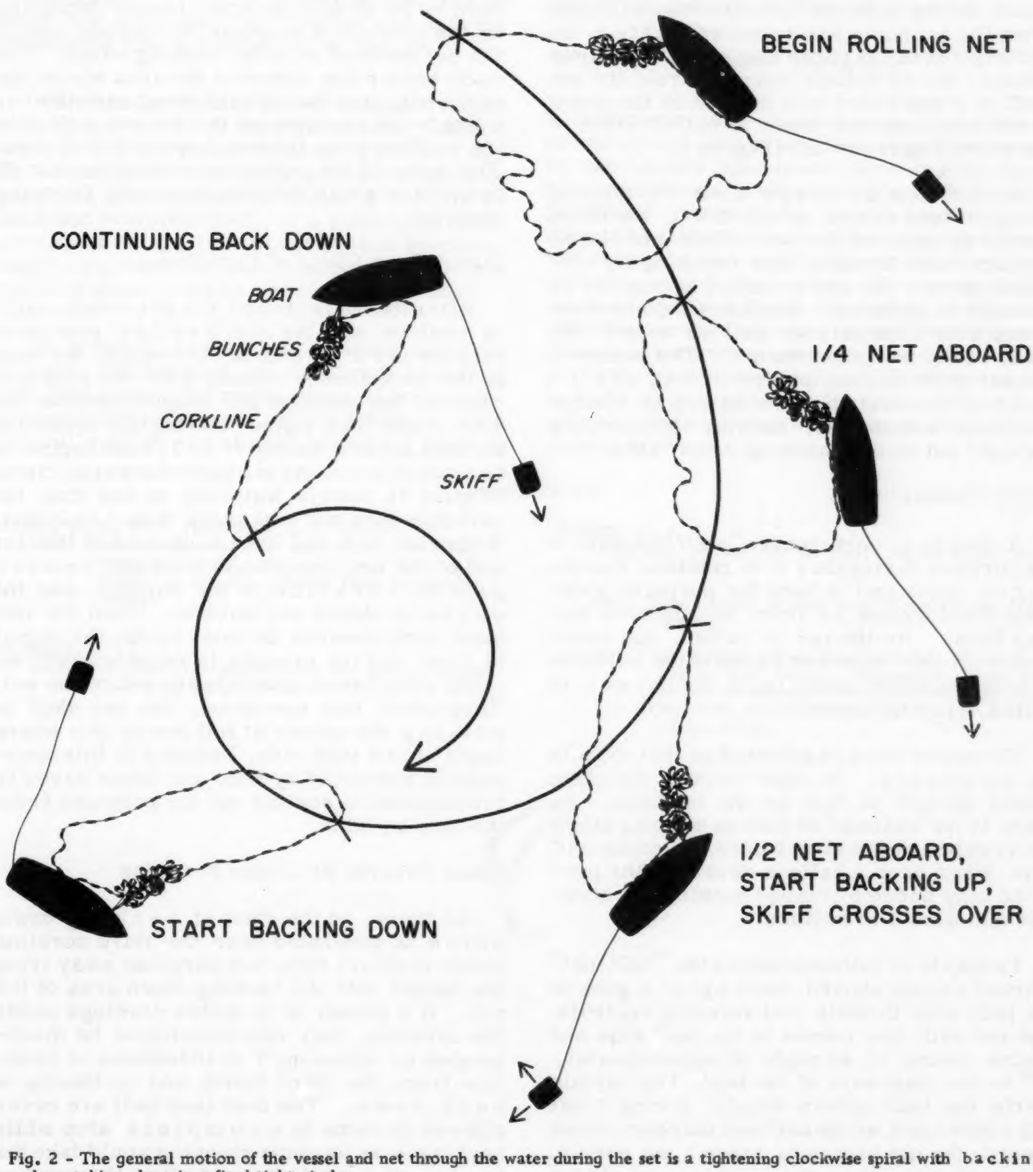

Fig. 2 - The general motion of the vessel and net through the water during the set is a tightening clockwise spiral with backing down taking place in a final tight circle.

fathom "bunches" in the bow corkline. The bunches are pulled in such a way that, as the purse rings rise to the surface, the corkline is fairly straight from the top of the third bunch to the area of corkline that will sink when the propoise are released. After the centerpiece of the purse cable starts to come aboard, the 60-fathom tow-line from the net skiff is transferred to a pad eye on the stern of the boat, and the stern is pulled clear of the stern bag in the net (Figure 1).

By the time the rings are on the ring stripper (see Green, et al., 1971), the stern should be clear of the net. Then net can be "rolled" onto the boat, thus reducing its circumference. The net is rolled as rapidly as possible to reduce the time the porpoise must spend within the net, as well as to pull the stern of the boat into the net. The action of the net skiff pulling as shown (Figure 1) causes the boat to move astern in a large clockwise semicircle, keeping the corkline straight out to the "backing down" area.

'Cork-Tender' Skiff

A man in a "cork-tender" skiff remains at the corkline during the set to retrieve the bow bunch lines and to keep the porpoise away from the corkline or from any pockets that may form. As the net is rolled, the cork-tender circles in the stern bend of the corkline to keep porpoise away from the net as it is pulled out of the water.

The power block is adjusted so that it rolls the net evenly. In other words, the chain comes aboard as fast as the corkline, so there is no "balloon" of excess webbing below the corkline in the area where the corks will sink. When such a balloon develops, the porpoise may become trapped outside the corkline and unable to surface.

Twenty to 30 fathoms before the "half-net" marker comes aboard, the captain goes to the port-side throttle and steering controls. The net skiff now comes to the port side and begins towing at an angle of approximately 80° to the main axis of the boat. The captain starts the boat astern slowly, giving it left full rudder and, as the half-net marker comes aboard, the net begins to stretch out evenly. This puts tension on the webbing and closes the meshes as much as possible--before the porpoise start coming in contact with the walls of the net-- and prevents a great deal of the entanglement that otherwise might occur. This marks the beginning of the "backing down" process.

After an additional 10 to 50 fathoms of net have come aboard, the exact amount depending on the number of porpoise, the captain orders the net secured with the choking winch. The cork-tender now moves to the area where the corks will sink during back-down and attaches a line to the corkline so that he may pull it to the surface when the tuna approach that area. The motor of the cork-tender must be shut off to avoid scaring the porpoise away from the opening.

Signal Tuna Clear of Corkline

After the net is choked, the net-tender skiff in position, and the boat headed astern so that the net is stretched out evenly, the man in the cork-tender signals when the tuna are clear of the corkline and headed towards the boat. Upon this signal, the captain opens the throttle approximately 1/ to 1/3 and begins to back the boat around in a tight clockwise circle (Figure 2), always watching to see that the corkline does not sink more than 2 to 3 feet. If the fish turn and head back toward the far end of the net, the man in the cork-tender pulls the corkline to the surface, and the captain closes the throttle. When the fish start back towards the boat again, the signal is given and the process is repeated until as many porpoise as possible are out of the net. Throughout this operation, the net skiff is pulling the seiner at full power at a sharp angle on the port side. Patience in this operation is rewarded by time and labor saved in brailing and in sorting out the porpoise from the tuna by hand.

Noise Diverts Reluctant Porpoise

At times, at the start of backing down, noise is generated near the third corkline bunch to divert reluctant porpoise away from the vessel into the backing-down area of the net. If a pocket of porpoise develops under the corkline, they can sometimes be disentangled by releasing 5 to 10 fathoms of corkline from the third bunch and continuing to back down. The boat (and net) are never allowed to come to a complete stop while backing down because stopping would take the tension off the webbing and allow the meshes to open up. If the meshes open, the porpoise may get their snouts or flippers into the opening, where they are held securely when the boat backs up again and the webbing tightens.

When all but the last few entangled porpoise have been released, the third bunch line is let go. This causes slack across the webbing and corkline so that the sunken corkline rises immediately. The cork-tender is now free to work his way down the corkline and pull the remaining live porpoise out of the net.

When the last half of the net has been rolled aboard, and while the bunt end is being "sacked up," if any porpoise remain in the net, one of the net skiff crew hangs a small aluminum platform over the side of the skiff next to the sack and removes them, In a substantial proportion of sets, all the porpoise are successfully removed by the combination of the backing down process and the cork tender.

In general, during bad weather or when a gear malfunction or "roll-up" (webbing wrapped around the purse rings slowing pursing procedure) occurs, every effort is made to roll enough net aboard to permit backing down as soon as possible. If adjustments to the net or gear must be made, the net skiff driver tows the boat in such a way as to keep the corkline stretched out evenly from the bow of the boat to the back-down area.

Efficiency and Speed Important

Efficiency and speed are very important to the entire operation. Average time spent by the vessel discussed here during three recent cruises was calculated for the "critical" time periods. It was found that 53 minutes, on the average, were required from the time the net was let go to the beginning of the backing down process. An average of 37 minutes elapsed from beginning of the set until the purse rings were on the ring stripper. Another 16 minutes were required for rolling net to the back-down position. These averages include sets made in adverse conditions of weather and sets on a wide range of porpoise school sizes.

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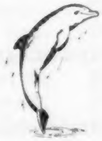

LONGLINES AND BILLFISH

John S. Gottschalk

The introduction of longline fishing gear for the taking of pelagic species opened the world's billfish stocks to significant exploitation. Billfishes are scattered over wide areas and so were never taken in large number by customary fishing methods. The world commercial fisheries were quick to seize the opportunity to "skim the cream" from these lightly harvested populations. The pressure of longlining immediately raised the question of overexploitation, particularly in those areas where angling for sailfish, swordfish, and the marlins was well established.

Stocks of fish may be overexploited to varying degrees. Some may be reduced to a point below the level necessary for attractive sport angling, some below the levels of profitable commercial return, and some to the point where their future as a stock or as a species may be in doubt. Because they range widely over the oceans, and are relatively scarce, scientific study of billfish has been inordinately expensive. Therefore, information needed to answer the question "are billfish being overfished?" is lacking. This paper attempts to summarize the general knowledge of the problem.

Japan Pioneered Longlining

Longline gear was originated and developed in Japan's home waters in the 1950s.

Table 1 - Common and Scientific Names of the Billfishes and Their General Distribution

Common Name	Scientific Name	Range
Swordfish	Xiphias gladius Linn.	Worldwide
Sailfish	Istiophorus platypterus (Shaw and Nodder)	Tropical Worldwide
Black marlin	Makaira indica (Cuvier)	Tropical Indo-Pacific
Blue marlin	Makaira nigricans (Lac.)	Tropical Worldwide
White marlin	Tetrapturus albidus Poey.	Tropical Atlantic
Shorebill spearfish	Tetrapturus augustirostris Tanaka	Tropical Indo-Pacific
Striped marlin	Tetrapturus audaz (Philippi)	Tropical Indo-Pacific
Longbill spearfish	Tetrapturus pfleugeri Robins and deSylva	Tropical Atlantic
Mediterranean spearfish	Tetrapturus belone (Raf.)	Mediterranean

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This article is condensed from one he presented at the 1972 Convention of the Outdoor Writers Association of America, Mazatlan, Mexico, June 26, 1972.

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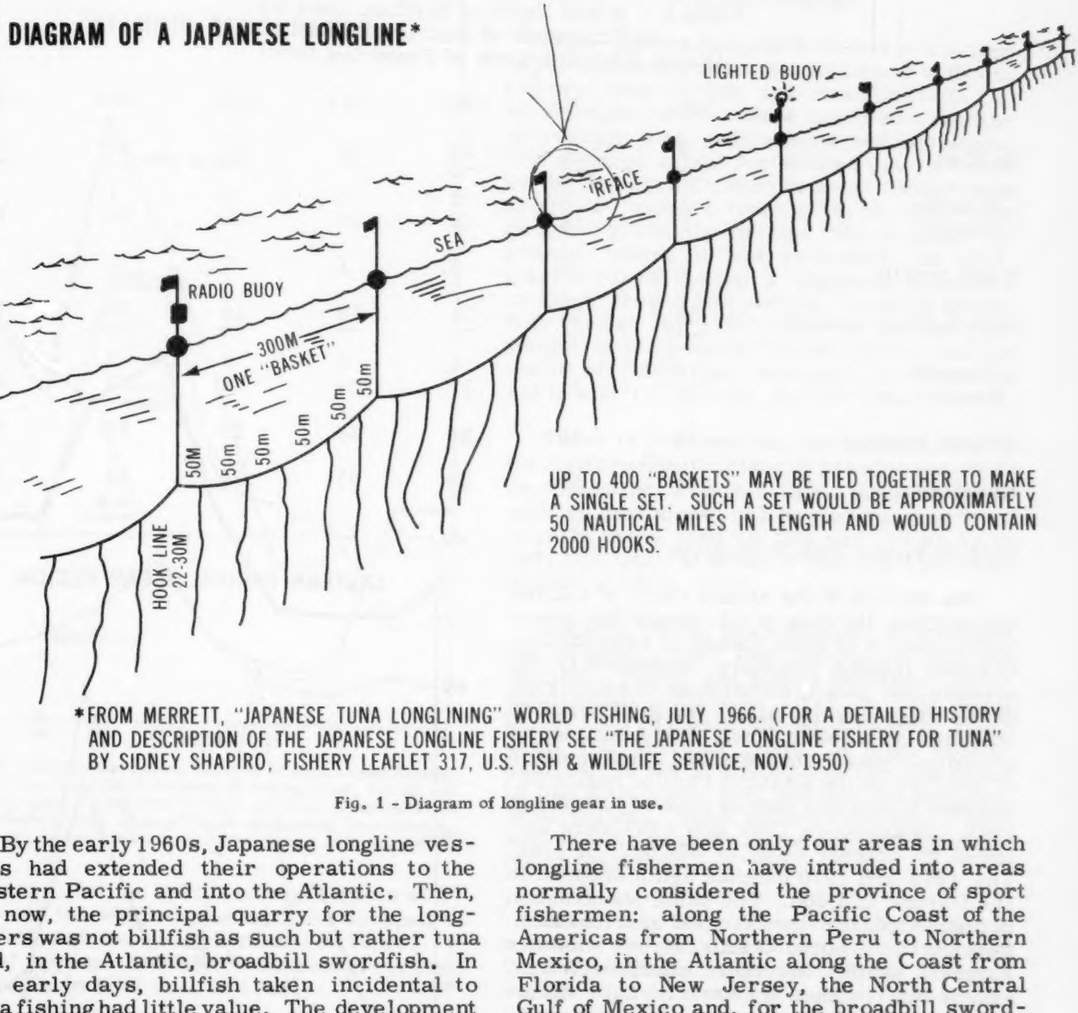

Fig. 1 - Diagram of longline gear in use.

By the early 1960s, Japanese longline vessels had extended their operations to the Eastern Pacific and into the Atlantic. Then, as now, the principal quarry for the longliners was not billfish as such but rather tuna and, in the Atlantic, broadbill swordfish. In the early days, billfish taken incidental to tuna fishing had little value. The development of "fish sausages" in Japan induced a limited market, but since 1966 most Japanese fishing vessels have been equipped with quick-freezing systems. The resultant improvement in quality increased demand. Now billfish command high prices in Japan because the flesh of striped marlin is considered equivalent to that of the expensive tunas. The Japanese fishing effort has spread throughout the world and takes about 70 percent of the world catch. Other countries now fishing longlines are Taiwan, Soviet Union, Mexico, and Cuba.

There have been only four areas in which longline fishermen have intruded into areas normally considered the province of sport fishermen: along the Pacific Coast of the Americas from Northern Peru to Northern Mexico, in the Atlantic along the Coast from Florida to New Jersey, the North Central Gulf of Mexico and, for the broadbill swordfish, the Atlantic from Cape Hatteras to Newfoundland.

For years swordfish have been harvested by harpooning. Longlining was introduced in 1962. The catch increased from 2100 metric tons in that year to 7500 in 1963. In 1969, the total catch in the Atlantic was 13,800 metric tons. A pronounced reduction in the catch of swordfish by U.S. and Canadian fishermen resulted from the finding in 1969 of mercury in swordfish flesh in excess of established limits in several countries.

Table 2 - World Catch of Billfish, 1964-70
in Thousands of Metric Tons
(From FAO Yearbook of Fisheries 1970)

	1964	1965	1966	1967	1968	1969	1970
Sailfish	8	16	14	15	16	15	11
Atlantic	1	2	2	1	2	1	1
Pacific	7	14	12	14	14	14	10
White marlin	4	5	3	1	1	1	1
Blue & Black marlin	38	33	31	28	26	26	26
Atlantic	8	6	4	3	3	3	3
Pacific	30	27	27	25	23	23	23
Striped marlin	28	26	24	26	25	25	25
Swordfish	34	32	33	33	34	38	38

Fate of Virgin Fish Population

The record of the annual catch of billfish exemplifies the fate of any virgin fish population when it is first opened to exploitation. Greater fishing pressure immediately increases the catch, sometimes to extraordinarily high levels, after which it tends to stabilize at a lower level. For example, as shown in Figure 2, the Japanese longline catch of sailfish in the Eastern Pacific region increased from 8,000 fish in 1962 to 417,000 in 1965. Declines in 1966 and 1967 were followed by another peak at 397,000 in 1968. The 1969 and 1970 catches again dropped to 194,000 and 263,000. The same phenomenon is recorded for the striped marlin catch. Data for the Atlantic Ocean catches shown in Figure 3 exhibit the same characteristics, except that catches apparently have stabilized at a relatively low level.

To account for the recorded fluctuations in catch, it is necessary to consider not only the size of stocks but the maneuverability of the fishery and the amount of effort. In the Eastern Pacific, the number of hooks was doubled in 1963, compared with 1962, and increased substantially again in 1964.

These increases in fishing effort, although presumably directed toward tuna, evidently produced great increases in the billfish catch. Likewise, the fishing effort increased from 42 million hooks to 50 million hooks (19%) from 1967 to 1968--with an increase in the marlin catch of 47 percent, and of sailfish 40

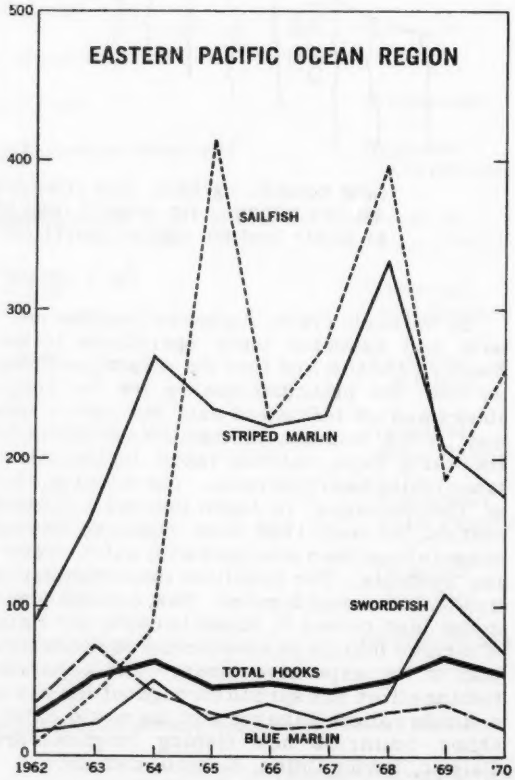

Fig. 2 - Japanese catch of billfish in the Eastern Pacific Ocean Region, 1962-70. Total hooks includes all fishing effort, billfish and tunas, given in millions of hooks per year. Catch shown in thousands of fish. (Annual Report on Japanese Tuna Longline Fishery, Research Division, Fisheries Agency of Japan, 1970).

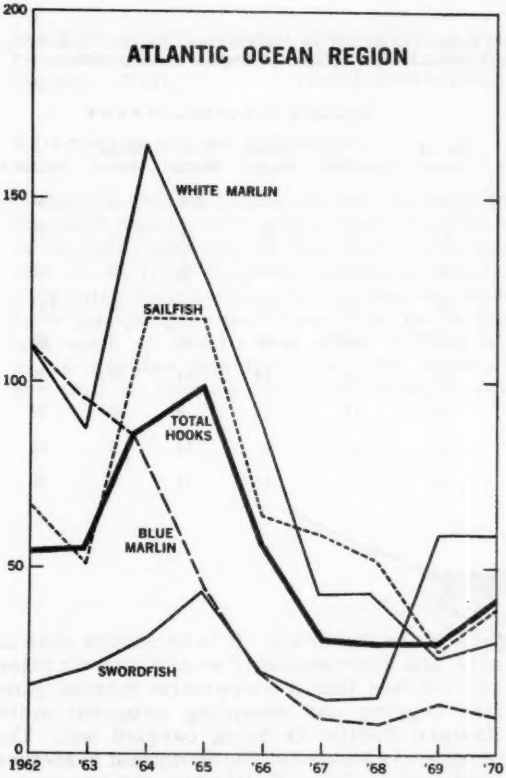

Fig. 3 - Japanese catch of billfish in the Atlantic Ocean Region, 1962-70. Total hooks includes all fishing effort, billfish and tunas, given in millions of hooks per year. Catch shown in thousands of fish. (Annual Report on Japanese Tuna Longline Fishery, Research Division, Fisheries Agency of Japan, 1970).

percent. Yet in 1969, with total hooks of 67 million, the striped marlin catch dropped to 208,000, and the sailfish catch to 194,000. It would appear that fish were relatively less available in 1969 than in 1968.

Availability, however, is not absolute evidence of reduced stocks. There may be a diversion of fishing effort to different areas. For example, the high sailfish catch in 1965 may have reflected the intrusion of the fishery into near-shore billfish concentrations. A similar movement might account in part for the relatively large increase in 1968 over 1967. A withdrawal of the longlines from near-shore fisheries to avoid direct competition with the intensive sport fishery off Baja California, or to seek better tuna catches elsewhere, might account for the decrease from 1968 to 1969.

Evidence of Population Changes

Other indices that give evidence of changes in population and characteristics are shifts in average size of fish and rates of catch. In the Eastern Pacific, there has been a decline in average size, indicating a reduced stock. The average weight for striped marlin taken by the Southern California sport fishery was about 150 pounds from 1952 to 1958, then dropped gradually through 1965 to about 130 pounds, where it has remained. In 1959, marlin taken during a Japanese scientific cruise averaged 143 pounds. Another scientific cruise in 1964 reported an averaged weight of 110 pounds (Talbot, 1970). Marlin taken off Mazatlan averaged 103 pounds in 1967, and 107 pounds in 1968 (Ware, 1970).

There is evidence that the success rate in the Eastern Pacific Fishery has also declined, an indication of fewer fish. An analysis of sailfish data shows catch rates ranging from slightly more than 10 fish per 100 hooks in 1964 to slightly less than 6 fish per 100 hooks in 1966 (Talbot, 1970).

Anglers fishing from Mexican sport-fishing centers report that fishing success has declined. Talbot and Squire (personal communication) estimated that in 1963 about 25,000 striped marlin and sailfish were taken along the Mexican coast. A more recent estimate is not available, but the concensus is that catch per boat per day has declined. Nevertheless, these waters continue to support one of the most attractive sport fisheries in the world.

Taken together, the available evidence confirms the parallel between the history of the billfish fishery adjacent to North America and the classic model of a lightly used fishery converted to a sustained fishery at a lower population level. At the present time, the population in the vicinity of Mazatlan appears to be adequate to support both an interesting sport fishery and a limited commercial fishery. The condition of fishing in the Atlantic and Gulf of Mexico is not as reassuring. If the exploitation continues to increase, reduction in the quality of the shore fishery is inevitable.

Need for International Management?

The possibility of a failing sport fishery leads to the question of the need to develop

Table 3 - Catches of Billfish by the Japanese Longline Fishery in the Eastern Pacific and the Atlantic Ocean Regions, 1962-1970, In Thousands of Fish. (Annual Report of Effort and Catch Statistics by Area in Japanese Longline Fishery, 1970. Research Division, Fisheries Agency of Japan, Tokyo.)

	EASTERN PACIFIC OCEAN REGION * * *						ATLANTIC OCEAN REGION * * * *					
	No. of Hooks	Swordfish	Striped Marlin	Blue Marlin	Black Marlin	Sailfish**	No. of Hooks	Swordfish	White Marlin	Blue Marlin	Black Marlin	Sailfish**
1962	25	13	84	37	2	8	54	19	111	111	3	67
1963	52	22	166	76	4	39	55	24	87	96	1	51
1964	62	50	270	43	4	86	85	31	163	84	0	118
1965	44	24	236	26	3	417	98	44	129	45	0	118
1966	48	36	223	22	4	232	54	22	89	22	0	65
1967	42	24	230	22	4	284	31	16	43	11	0	59
1968	50	37	338	28	4	397	30	17	43	9	0	52
1969	67	112	208	34	4	194	30	57	27	14	0	28
1970	52	67	177	20	3	263	42	57	32	11	0	39

* In millions of hooks
** Includes spearfish
*** West Coasts of the Americas to 130° W. Long.
**** Entire Atlantic Ocean

a rational international management system for taking billfish. Treaties such as that establishing the International Commission for the Conservation of Atlantic Tuna and Tuna-like Fishes (ICCAT) provide mechanisms by which pelagic species such as the billfish can be given necessary protection. Actions of the international bodies are being designed to protect the resource itself, with the ultimate goal of benefiting all fisheries. There is ample authority within ICCAT, for example, to establish regulations that give special protection to billfishes when it can be demonstrated that such protection is needed to conserve the resource at any agreed-upon level of abundance. Other arrangements, such as extension of fishery jurisdiction to as much as 200 miles, would be ineffective in conserving the pelagic migratory species. Such arrangements would give individual nations authority over fishery stocks in their territorial seas--but cannot guarantee effective conservation of migratory species that travel widely and may be found off many countries in various seasons.

Cooperative Tagging Program

To make United States participation in international regulatory bodies effective, it is essential to have adequate information on the biology of billfishes and the characteristics of the fisheries. It is to secure data on size and distribution of stocks, growth rates, and catches that a cooperative marine game fish tagging and sampling program in the Eastern Pacific is being carried out. The program is located at the Southwest Fisheries Center at La Jolla, California, the headquarters for work on tuna and related fishes undertaken by the National Marine Fisheries Service. Limited information on general biology--particularly size, condition, and spawning--has been obtained from specimens taken off Baja California and Mazatlan. The principal effort of the Pacific billfish work has been in a cooperative tagging program with the Mexico Department of Fisheries, International Game Fish Association, the Woods Hole Oceanographic Institution, and the California Department of Fish and Game. During 1971, 2,412 marine game fish were tagged by cooperators. Since 1954, anglers have tagged 15,070 billfish in the Pacific. Returns of tags have been slightly under one percent for striped marlin, a trace for sailfish (8 of 4,613 fish tagged) and black marlin (2 of 538 tagged), and none for 203 tagged blue marlin. Striped marlin show a southerly movement from Baja and Mazatlan, where tagged, toward the Revillagigedo Islands in late spring and summer. There are indications of a movement northwestward from Cape San Lucas to the west coast of Baja in

early summer; other recoveries show a movement to southern California in the fall (Squire, 1972).

Information Needed and Sought

Much additional knowledge concerning the status of populations, migrations, and biology of the billfishes will be necessary to formulate sound long-range management policies governing their utilization. Substantial funds have been programmed for marine game fish, and work on marlin and other billfish will share greater attention. In 1972, efforts in the Gulf of Mexico and South Atlantic were strengthened. A substantial increase is planned for 1973 in the studies of billfish off Southern and Baja California. Billfish and other game species will be collected routinely and systematically by the comprehensive program of high-seas sampling known by the acronym MARMAP. Ultimately, MARMAP will involve extensive surveys to determine the abundance, distribution, and growth characteristics of important game and commercial species--also, spawning locations and distribution patterns of eggs and larvae. Concurrently, investigations will be made of the physical, chemical, and biological factors controlling the distribution and abundance of fish, eggs, and larvae.

DOUBLE-RIG TWIN SHRIMP-TRAWLING GEAR USED IN GULF OF MEXICO

Harvey R. Bullis Jr. & Hilton Floyd

Double-rig shrimp trawling was developed in the Gulf of Mexico during the Mid-1959s. By 1958, it had become the principal trawling method used in the offshore shrimp fishery (Knake, et al., 1958). Over the following 15 years, other advances in methodology and technology were concerned mostly with design of the outriggers, mast structures, and other rigging components related to handling problems of the double-rigged gear.

During the past year, however, there have been scattered attempts to test the application of a twin trawling technique similar to that now being used experimentally in the North Sea sole fishery (Anonymous, 1970 and 1971). Some of these trials have yielded encouraging results and have excited much curiosity throughout the shrimp industry. The purpose of this paper is to describe one twin shrimp-trawling rig that has been fished along the Texas coast during the past year.

TWIN TRAWLING

The principle of twin trawling is to tow two trawls using a single pair of otter boards or doors. The two trawls are joined at the head rope and foot rope to a "neutral door," which is connected to a third bridle leg. The neutral door is called "center bridle weight ski" in Europe and "sled" in the Gulf shrimp fishery. Generally speaking, the same total head rope length is maintained for each twin-rig component as was used in the single trawl units on a double-rigged trawler. That is, if a trawler had been towing two 70-foot head rope length trawls, it would now tow four 35-foot head rope length trawls, two on each outrigger.

Rig of 'La Fourche'

The following rig description was obtained from a unit designed by Captain J. F. Wiley, Aransas Pass, Texas, for the 380 HP shrimp trawler "LA FOURCHE". The trawler was conventionally outfitted and no standing rigging modifications were necessary for the conversion to twin trawling.

The towing warps were standard $\frac{5}{8}$-inch diameter trawl cable. The three legged bridles of $\frac{1}{2}$-inch diameter cable were 40 fathoms long. The twin trawls were standard 35-foot head rope flat shrimp trawls that had been modified by having the outside footropes and headropes three feet longer than those secured to the sled. This was to compensate for the distance lost along the towing axis by the equal length of all three bridles.

Each wood trawl door was conventionally chain rigged, seven feet long by 36 inch high. The two lazy lines were secured to each other and then tied to a tag line secured to the sled.

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NEUTRAL DOOR OR "SLED" FOR TWIN TRAWL

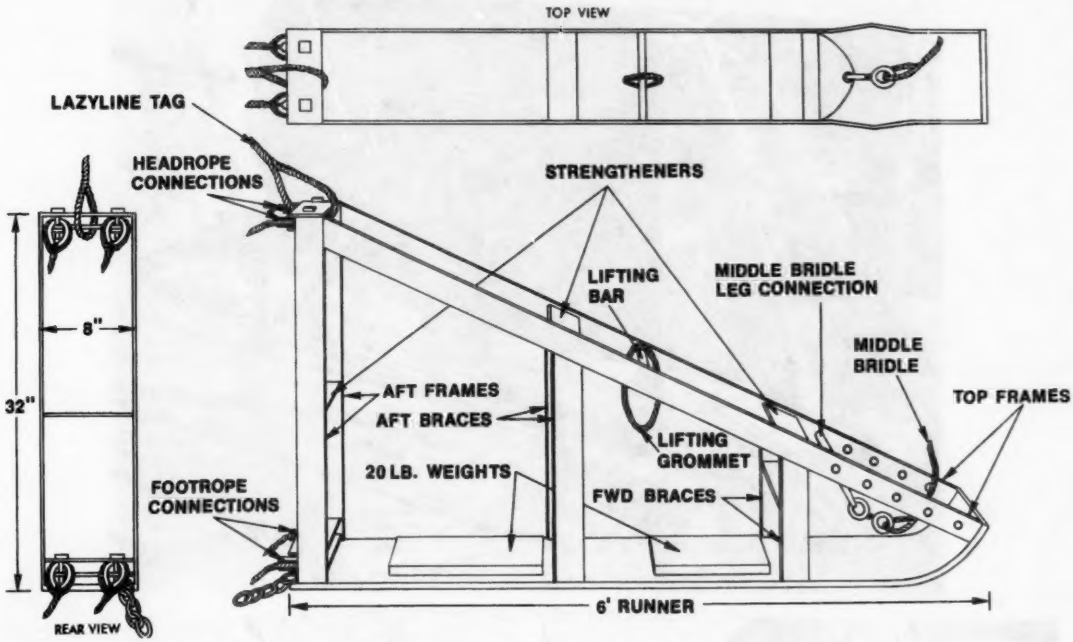

Fig. 1 - Diagramatic sketch of a Gulf of Mexico twin-trawl sled and terminology.

The sled design used by Captain Wiley was six foot long, 32 inches high at the aft end, and rode on an eight-inch-wide, one-inch thick steel shoe. Specifications and construction details of the Wiley sled are shown in Figure 1.

Reported Advantages

There have been no sustained comparative tests to prove the reported increased efficiency of the twin trawl array. There are now about 10 vessels so rigged in the Gulf of Mexico. The captains we have talked to have offered several apparent advantages over the conventional double rig. Most significant is the reported increase in fishing efficiency: in some cases, as much as 25% over the conventional double-rig system. Some other apparent advantages are the light weight and ease of handling two 35-foot trawls, as opposed to a single 70-foot trawl. The combined weight of netting of two 35-foot nets is significantly less than one 70-foot net. The two 35-foot nets can be spread with a single pair of seven-foot trawl doors; a 70-foot trawl would require 10- to 12-foot doors. This means that nets can be towed with significantly less than maximum horsepower, ideally at three to four knots. It is claimed, also, that the vessel can make sharper turns with fewer incidents of tangling as a result of crossing the towing warps.

Figures 2 through 6 illustrate the gear aboard the "LA FOURCHE".

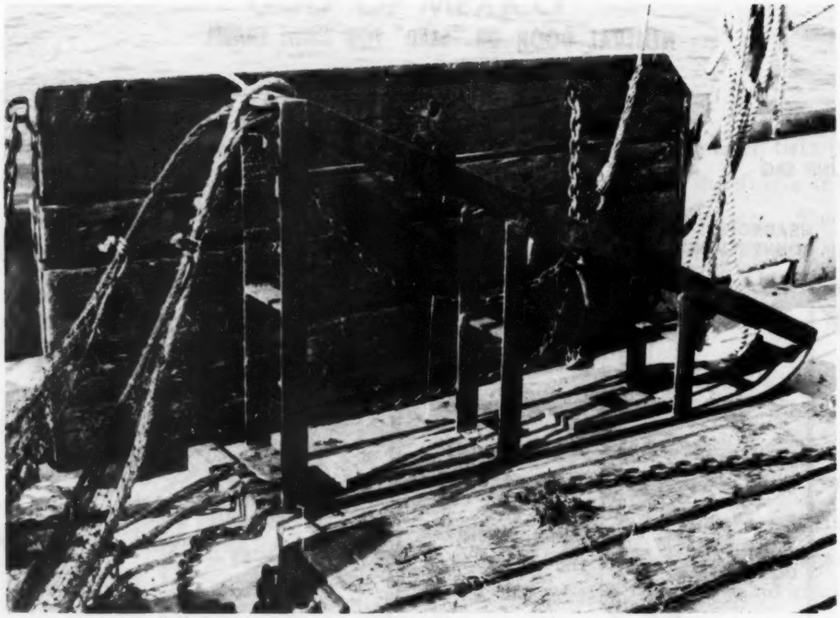

Fig. 2 - Side view of sled fully rigged and ready to set.

Fig. 3 - Front view of sled showing towing bridle and lazyline tag.

Fig. 4 - Aft view of sled and doors in position for pickup to outrigger boom.

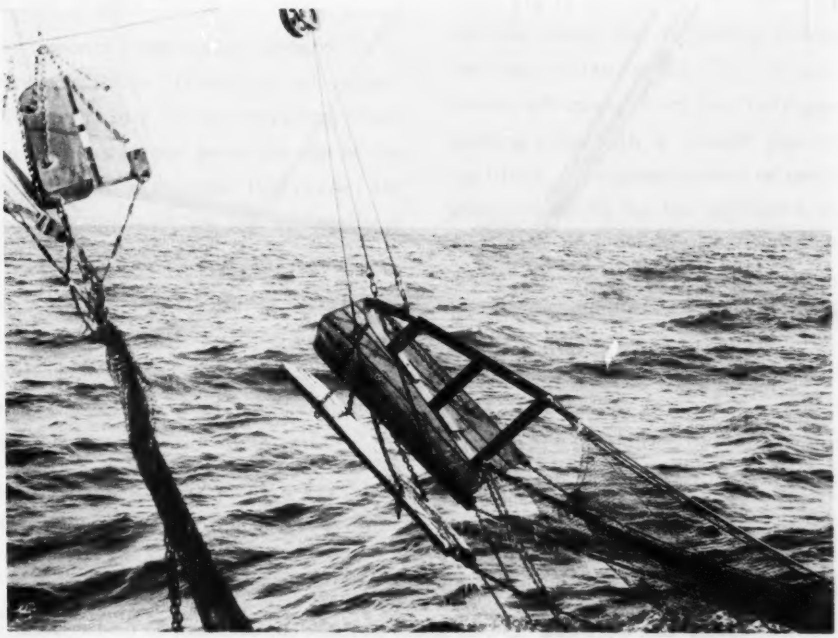

Fig. 5 - Sled and doors being slacked from outrigger boom tip.

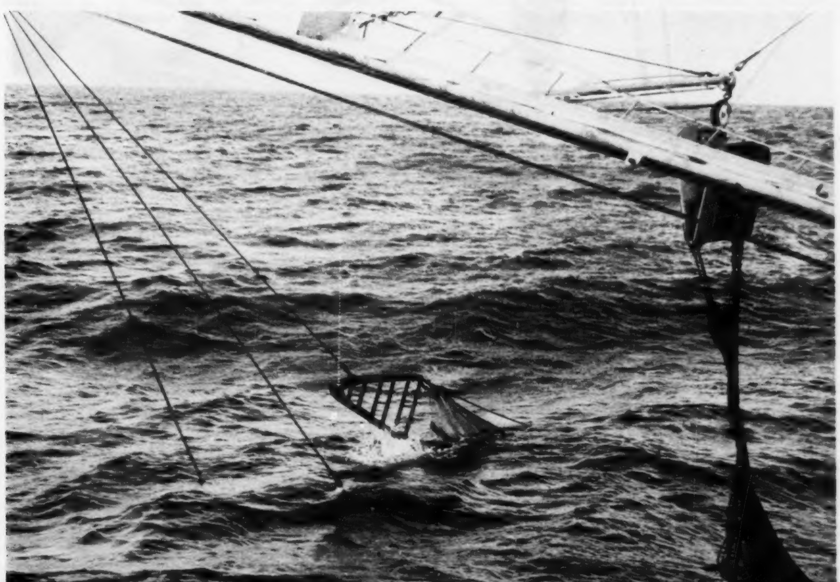

Fig. 6 - Doors submerged and sled about to submerge during trawl setting.

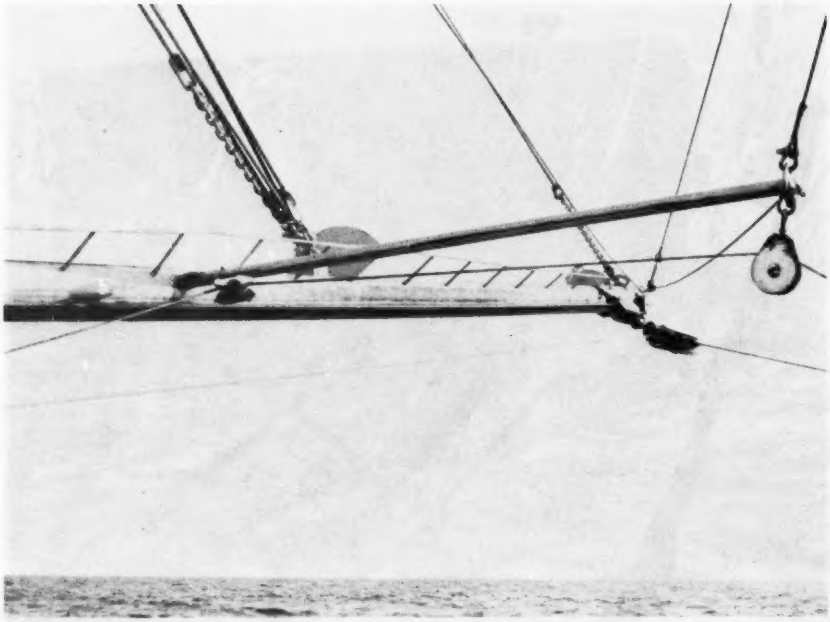

Fig. 7 - Outrigger boom with welded "T" track holding the sliding clip that carries the trawling block. The clip is fully extended to the boom tip and is under towing strain.

Fig. 8 - Close-up of the "T" track and sliding clip that carries the outrigger boom trawling block.

Traveling Out-Rigger Block

Another recent innovation aboard U. S. shrimp trawlers is the "traveling out-rigger block". The principle of the traveling block is to move the trawl door from the tip of the outrigger boom to alongside the vessel for easier access to the lazy line and to facilitate hoisting of the cod end.

Figure 7 shows the traveling block fully extended to the tip of the out-rigger boom and in trawling position. Figure 8 shows the block near the base of the boom and in a slack condition.

There does not appear to be a prefabricated, off-the-shelf, traveling block system. Each rig is fabricated on individual specifications using the following components: a one-inch-thick steel "T" is welded to the lower aft-quarter of the outrigger boom; a sliding clip with a welded pad-eye holding the block, also constructed of one-inch-thick steel, rides on the tee as shown in Figure 8. The clip is pulled out to the boom tip using a tag line operated from the winch. It slides back to the side of the vessel when the tag line tension is eased.

Comparative tests and evaluation of twin trawls are scheduled during the coming year. A detailed report will appear later.

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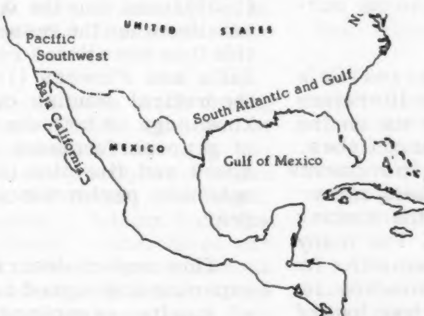

TRAWL STUDIES BASED ON BOTTOM CURRENT MEASUREMENTS

S. B. Saila and W. H. Mowbray

Experiments were designed to test whether the yields of certain important bottom organisms by bottom trawling could be affected by the direction of the tow in relation to prevailing bottom currents. Specifically, the trawl was towed with, against, and across the direction of the prevailing bottom currents, which were measured shortly before the tows were made. It was found that significant improvements in the yields of flatfish species were achieved with tows made against the bottom currents or across the currents in contrast to those made in the direction of the bottom current under otherwise similar conditions. Lobster yields were also significantly improved by orienting the trawl against the bottom current. Some evidence was also obtained to suggest that the yield of crabs and pelagic fishes might also be improved by orienting the gear against prevailing currents in its vicinity. However, further work with these species needs to be done in order to provide conclusive information.

Although it has been known for some time that bottom and surface currents in many areas may be quite different, relatively little trawl gear research has been done with an adequate knowledge of bottom currents. This lack of information may cast doubt on the reliability of some instrumented gear results. In addition, Carruthers (1964) noted that knowledge of bottom currents might be useful in improving the catching efficiency of trawl gear by permitting determination of an optimum attack angle of the gear relative to the orientation of given fish species to the current.

Laevastu (1965) and Laevastu and Hela (1970) have reviewed much of the literature concerning the effects of currents on the swimming behavior and orientation of fishes. Their conclusions indicate passive movements with the current and normal swimming movements against it, depending upon the species and the environmental conditions. For many demersal species, available information to data suggests that normal orientation is against the current with an effective loss of actual swimming speed. An article quoted by Carruthers (1955) regarding some Norwegian work pointed out that the current at fishing depth often runs in a different direction from that at the surface. Furthermore, this factor seemed more pronounced at depths of 50-60 fathoms than at depths of 27-33 fathoms. At that time, Norwegian cod fishermen urged that means be made available to them to know how the water moved at fishing depth in order to improve their catches.

Some evidence is also available to indicate that the geometry of the trawl net is affected by the direction of the tow. Ketchen (1957) found that the opening of the trawl was smaller when the vessel was running with the tide than when it was running against the tide. Saila and Flowers (1969) have shown from theoretical studies of fishing tactics that a knowledge of both the behavior of fishes and of gear performance in relation to current speed and direction is requisite to obtaining optimum performance from towed fishing gear.

This report describes the results of an experiment designed to test whether the catch of marine organisms by trawling could be affected by the direction of the tow based on knowledge of the direction and velocity of bottom currents near the fishing ground.

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MATERIALS and METHODS

The directional towing experiment was conducted in an area of approximately one mile in radius centered at 41^{o}-17 N, $71^{o}31$ W in Rhode Island Sound during July-September 1972. The depth at this location ranged from 100-150 feet with a depth of 138 feet at the center. Bottom sediments were fairly uniform and consisted primarily of compacted muds.

Currents were measured with a type 110/119 Remote Reading Current Meter with Temperature and Depth. This instrument is manufactured by Environmental Devices Corp., Marion, Massachusetts. The remote reading deck read-out unit was equipped with 200 feet of connecting cable to the axial flow, ducted impeler current meter. The meter was lowered to depth on a one-half-inch diameter polypropylene rope, which had a lead weight attached one fathom below the meter. The deck read-out unit permitted sequential measurements of water temperature, depth, current speed, and current direction.

The ducted fan sensor on this instrument has a speed range from 0-2.5 knots. According to the manufacturer, the resolution is ± 0.05 knot and the accuracy is $\pm$ 3 percent of full scale deplection. Magnetic current direction reads from 0-360^{o} with a sensitivity of $\pm 5^{o}$ at 0.05 knot, a resolution of $\pm 1^{o}$ and an accuracy of $\pm$ 1 percent above 0.05 knot.

Current measurements were made during each day of the experiment while anchored at the center of the experimental area. Measurements of direction and velocity were taken at the surface (approx. 1 fathom), mid-depth, and at the bottom (approx. 1 fathom from the sediment-water interface). After three experimental tows, the current measurements were repeated while anchored, and from these data the directions for the next three tows were determined. On some occasions when conditions were unusual, additional current measurements were made at the end of the sixth tow. Carruthers (1955) has described a simple fishermen's current cone consisting of a conical casing which can vary its attitude according to the speed and direction of water flow. He has developed a simple mechanism for recording these factors. Later, Carruthers (1964) described a Pisa Current Indicator consisting of a bottle partly filled with jelly and a circular compass in the bottle which permitted crude estimates of current speed and direction as the jelly set. Neither of these devices was considered suitable for the purposes at hand due to their limitations in operational accuracy.

The trawling experiment was conducted with a standard 71-91 Yankee trawl operated from a 57-foot LOA western rigged stern trawler powered by a 671 GM diesel. The same trawl was used during the entire experiment and no changes were made in any of the rigging. All tows were made at a constant 1450 r.p.m. engine speed.

The entire experiment was planned prior to execution, and it consisted of two replicates of three tow directions during each day of operations. It was designed to compare the relative effectiveness of trawling against the direction of the prevailing bottom current (A), with the direction of the prevailing bottom (W) and crossing at 90^{o} to the direction of the prevailing bottom current (C).

The duration of each experimental tow was 15 minutes from the time the wire was out to the time hauling back was initiated. At the end of each tow, all organisms captured were placed in containers and labeled with the date, treatment, and replicate number. All counts and weights were recorded for individual species upon return to the field laboratory.

The experimental design used for this study consisted of a two-factor analysis of variance model with replication. The set of treatments which consisted of tows against, with, and across the bottom current was replicated two times each day under similar conditions.

The number of replications within days and the number of days for the duration of the experiment were determined by economic and logistic constraints. For example, it was found that six experimental tows could be made within a day and still permit time for processing the fish and crustaceans upon return to the laboratory. Conditions on the experimental site change with time, and extension beyond the period considered would not have increased experimental precision appreciably.

RESULTS

Table 1 lists some of the current measurements and temperatures obtained during the experiment. Although some midwater observations were made, these were not directly utilized in the experiment and are omitted from this table. Graphical representation of these limited data as vectors suggested that the circulation is dominated by the east-west semidiurnal tide, and that there may be a small net nontidal transport in a southwesterly direction. These results are roughly in correspondence with more extensive current measurements made in nearby areas by Polgar (1972) and Shonting (1969).

There was relatively little regularity in the observed differences between surface and bottom current directions, and this justified empirical observations immediately prior to fishing operations. The speed of bottom currents in the experimental area was found to be greater than surface values in only seven of the 19 sets of data. These observations are in contrast to those reported for deeper Scottish waters by Carruthers (1955); there, near-bottom currents of 92 fathoms in the Firth of Clyde were faster than those near the surface. In general, the speed of the bottom currents in this study had a smaller range (0.13-0.50 knot) than the surface values (0.15-1.00 knot) and a lower average value, which was on the order of 0.30 knot.

Because all organisms captured were separately handled by species, it was possible to assess the response of individual species or ecologically similar groups of

TABLE 1 SELECTED HYDROGRAPHIC DATA OBTAINED DURING THE TRAWL TOW DIRECTION EXPERIMENT IN RHODE ISLAND SOUND. 1972.

			SURFACE DATA			BOTTOM DATA		
DATE	TIME	WATER DEPTH (ft)	SPEED (knots)	DIRECTION (Magnetic)	TEMP. (°C)	SPEED (knots)	DIRECTION (Magnetic)	TEMP. (°C)
7/21/72	09:05	134	0.20	290	20.0	0.27	120	11.5
7/21/72	13:10	105	0.50	100	21.0	0.35	250	-
7/26/72	09:50	125	0.30	225	19.3	0.40	300	10.5
7/26/72	12:30	145	0.30	180	19.7	0.13	200	10.5
7/26/72	15:10	145	0.70	120	19.2	0.15	200	10.5
7/27/72	10:05	140	1.00	270	19.0	0.35	290	11.2
7/27/72	13:00	138	0.15	270	19.0	0.20	170	11.5
7/28/72	10:10	140	0.45	290	19.1	0.32	270	11.4
7/28/72	13:45	145	0.35	175	19.0	0.15	225	11.5
8/4/72	10:10	138	0.30	90	19.5	0.30	150	11.5
8/4/72	13:05	148	0.25	150	20.1	0.35	270	_2.6
8/16/72	10:30	140	0.20	270	18.0	0.35	300	12.4
8/16/72	12:40	145	0.50	285	18.2	0.40	300	11.6
8/31/72	09:30	135	0.45	10	18.0	0.15	355	14.1
8/31/72	12:10	140	0.50	90	18.0	0.25	5	13.2
9/6/72	09:55	140	0.50	295	18.6	0.15	260	14.2
9/6/72	12:40	145	0.40	70	18.6	0.50	135	14.2
9/7/72	09:45	135	0.85	285	18.6	0.25	315	14.1
9/7/72	12:10	140	0.25	235	18.1	0.30	225	13.9

organisms. Of special significance to New England fishery operations are some species of flatfishes, especially yellowtail and winter flounder. Thus, the results of this experiment using all species of flatfishes captured (window-pane--Scopthalmus aquosus, winter flounder--Pseudopleuronectes americanus, fourspot flounder--Paralichthys oblongus, summer flounder--Paralichthys dentatus, and yellowtail flounder Limanda ferruginea) are considered first.

Examination of the treatment means clearly showed that 15-minute tows made in the direction of prevailing current (W) produced about 29 pounds less than tows across the current (C) and about 18 pounds less than similar-duration tows against the current (A). It is clear also from examination of these data that the yield from the experimental area improved considerably toward the end of the study, and that there is considerable variation in the day-to-day and treatment results. The data of Table 2 were therefore subjected to statistical analysis. The results, shown in Table 3, indicated that the differences observed were of a causal nature and cannot be attributed to chance alone. The interaction term which relates to the interplay of the factors at work was not statistically significant in the abovementioned data.

produced a still lower value than towing with the current, but these values are not very different. The results of an analysis of variance for these data are shown in Table 5. From the table it was evident that the interaction term is negligible, but the differences among treatments (tow directions) were highly significant. The observed improvement in trawling efficiency induced by towing against the current was not a chance phenomenon with respect to the lobster data.

Jonah crabs (Cancer borealis) were also taken consistently during the trawling experiment. The crab data resulting from seven days of trawling are shown in Table 6. Data for only seven days were used because environmental conditions and crab abundance changed dramatically during the last two days. Again, it appeared from a visual comparison of treatment means that more crabs were taken by towing across or against the current then by towing in the direction of the prevailing bottom current. It was also evident that the total yields by day and by individual treatments were quite variable. This variability is further substantiated by the results of the analysis of variance shown in Table 7. The treatment effects (tow directions) were not statistically significant at the conventional 0.05 probability level. However, they were significant at the approximately 0.15 probability level. Interaction effects were not significant in this instance either.

Table 3 - Two-Way Classification Trawl Tow Direction Experiment, 1972
(Weight of all Flatfish species per 15 minute tow in pounds)

Source of variation	Degrees of freedom	Mean square	F
Tow direction	2	3747.05	2.995*
Day	8	38324.44	
Interaction	16	2792.50	2.232
Error	27	1250.88	
Total	53		

Significant at $\alpha = 0.05$

Since the lobster (Homarus americanus) is a very valuable organism, the tow direction experiment was also analyzed to assess lobster response. Table 4 illustrates the tow data with the number of lobsters taken per 15-minute tow as the response variable. The last row of this table showed that almost twice as many lobsters (25 versus 13) were taken by towing against the current than with the current. Towing across the current

Similar analyses were performed for total benthic fishes (which included 13 species) but excluded the pelagic forms such as shad, bluefish, hake species, and herrings. These data did not reveal any significant differences in the total yield as related to current direction. A tentative explanation for this is

TABLE 2 Data for Trawl Tow Direction Experiment - 1972. The Response Variable is Pounds of Flatfish Species Caught per 15 Minute Tow. W, C, and A refer to tows made with, across and against the bottom current direction, respectively.

DAY	TREATMENT W	TREATMENT C	TREATMENT A	TOTAL	MEAN
7/21	63.0	102.0	53.5		
	23.0	14.5	19.5		
	86.0	116.5	73.0	275.5	45.9
7/26	16.0	15.5	50.0		
	17.0	55.5	31.5		
	33.0	71.0	81.5	185.5	30.9
7/27	29.5	125.5	27.5		
	23.0	174.0	22.0		
	52.5	299.5	49.5	352.0	58.7
7/28	18.5	43.0	11.5		
	44.5	83.0	18.5		
	63.0	126.0	30.0	219.0	36.5
8/14	116.0	104.5	137.5		
	65.0	94.0	83.0		
	181.0	198.5	220.5	600.0	100.0
8/16	90.0	46.0	137.0		
	57.0	56.0	81.0		
	147.0	102.0	218.0	467.0	77.8
8/31	46.5	153.0	154.0		
	75.0	129.5	192.0		
	121.5	282.5	346.0	750.0	125.0
9/6	234.0	264.5	296.5		
	313.0	328.0	142.5		
	547.0	592.5	439.0	1578.5	263.1
9/7	179.0	156.5	231.5		
	209.0	197.0	254.0		
	388.0	353.5	485.5	1227.0	204.5
	=	=	=	=	=
TOTAL	1619.0	2142.0	1943.0	5654.5	670.4
MEAN	89.9	119.0	107.9	314.1	74.5

Table 4 Data for Trawl Tow Direction Experiment - 1972. The Response Variable is the Number of Lobsters Caught per 15 Minute Tow. W, C and A refer to tows made with, across and against the prevailing bottom current direction respectively.

DAY	TREATMENT			TOTAL	MEAN
	W	C	A		
7/21	0.0	0.0	4.0		
	1.0	1.0	38.0		
	1.0	1.0	42.0	44.0	7.3
7/26	4.0	6.0	25.0		
	10.0	2.0	17.0		
	14.0	8.0	42.0	64.0	10.7
7/27	21.0	9.0	56.0		
	11.0	6.0	40.0		
	32.0	15.0	96.0	143.0	23.8
7/28	11.0	10.0	21.0		
	32.0	8.0	35.0		
	43.0	18.0	56.0	117.0	19.5
8/4	9.0	22.0	25.0		
	25.0	12.0	17.0		
	34.0	34.0	42.0	110.0	18.3
8/16	28.0	15.0	32.0		
	13.0	12.0	42.0		
	41.0	27.0	74.0	142.0	23.7
8/31	7.0	29.0	18.0		
	4.0	10.0	23.0		
	11.0	39.0	41.0	91.0	15.2
9/6	23.0	6.0	19.0		
	22.0	15.0	18.0		
	45.0	21.0	37.0	103.0	17.2
9/7	8.0	4.0	11.0		
	6.0	4.0	3.0		
	14.0	8.0	14.0	36.0	6.0
	=	=	=	=	=
TOTAL	235.0	171.0	444.0	850.0	141.7
MEAN	13.1	9.5	24.7	47.2	15.7

Table 5 - Two-Way Classification Trawl Tow Direction Experiment, 1972
(Number of lobsters per 15-minute tow transformed by $\sqrt{X + 0.5}$.)

Source of variation	Degrees of freedom	Mean square	F
Tow direction	2	18.31573	18.31573**
Day	8	6.00725	
Interaction	16	1.65897	1.65897
Error	27	0.92701	
Total	53		

Significant at α = 0.01

Table 6 Data for Trawl Tow Direction Experiment - 1972. The Response Variable is Pounds of Crabs caught per 15 Minute Tow. W, C, and A refer to tows made with, across, and against the bottom current direction, respectively.

DAY	TREATMENT W	TREATMENT C	TREATMENT A	TOTAL	MEAN
7/21	18.0	4.5	14.0		
	16.0	40.0	36.0		
	34.0	44.5	50.0	128.5	21.4
7/26	27.0	19.0	33.0		
	27.5	17.0	44.0		
	54.5	36.0	77.0	167.5	27.9
7/27	17.0	27.5	30.5		
	23.5	67.0	35.0		
	40.5	94.5	65.5	200.5	33.4
7/28	37.0	50.0	25.0		
	44.5	41.0	25.0		
	81.5	91.0	50.0	222.5	37.1
8/4	10.0	45.0	34.0		
	43.0	29.0	44.0		
	53.0	74.0	78.0	205.0	34.2
8/16	23.0	43.0	24.0		
	14.0	19.0	12.0		
	37.0	62.0	36.0	135.0	22.5
8/31	18.0	27.0	48.0		
	6.0	22.0	26.0		
	24.0	49.0	74.0	147.0	24.5
TOTAL	324.5	451.0	430.5	1200.0	201.0
MEAN	23.2	32.2	30.8	85.7	28.7

Table 7 - Two-Way Classification Trawl Tow Direction Experiment, 1972
(Weight of all Crab species per 15-minute tow)

Source of variation	Degrees of freedom	Mean square	F
Tow direction	2	329.268	2.046
Day	6	232.151	
Interaction	12	170.198	1.094
Error	21	155.536	
Total	41		

that such a diversity of species has a variety of responses to currents which average out significant differences in the yield for a particular tow direction.

Although the gear fished was bottom trawl gear and not midwater gear, a preliminary analysis of the response of pelagic fishes to tow direction was also made. The response variable was the pounds of all hake species, shad, and herring per 15-minute tow. The results of the experiment showed an increase in the catch of pelagic fish when the net was towed against the prevailing bottom current as contrasted with tows made in the direction of the current. The results of the statistical analysis of these data were inconclusive, primarily because the gear used was not designed for catching these species, and there was considerable variation in the yield per tow.

CONCLUSIONS

The results of these experiments with directional trawling demonstrated that significant increases in the yields of flatfishes and lobsters were achieved under the conditions of the experiment. These amounted to an approximately 27 percent increase in the yield of flatfishes when tows were made against or across the bottom current versus tows made in the direction of the bottom flow. In the case of lobsters, almost a doubling of yield was obtained when tows were made against the bottom current versus the other directions of tows. The explanation for these improvements is tentatively suggested as being related to the net fishing harder by digging into the sediments and therefore fishing more efficiently for these bottom forms. The tension on the tow warps as measured by warp tension meters was higher during tows made against bottom currents than during tows made in the direction of bottom currents. The significance of this work relates to increased trawling efficiency based on knowledge of bottom currents. The limitations of this work include the fact that no tests were made with midwater trawls, which would have provided more objective tests regarding pelagic fishes. The instrumentation used in this study was relatively expensive, and it remains for someone to develop relatively cheap and efficient means for measuring current direction on the bottom suitable for fishermen to use. In addition, an examination of the current and yield data demonstrated that it would have been desirable to have had more frequent measurements of bottom current directions in order to further reduce the unaccountable variation observed.

ACKNOWLEDGMENT

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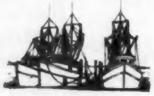

STATUS OF FISH STOCKS OFF NORTHEASTERN UNITED STATES

Herbert Stern Jr. and Bradford E. Brown

Total 1971 landings (preliminary) of finfish by all countries off the U.S. coast in ICNAF Subareas 5 and 6 (Virginia to Maine, Fig. 1) were 1,356,382 metric tons (MT)--278,088 MT above 1970. The U.S. finfish landings were 460,799 in 1970 and 456,994 MT in 1971. Table 1 summarizes catches by species and country.

In an attempt to stabilize the fishery, the International Commission for the Northwest Atlantic Fisheries (ICNAF) proposed new regulations at its annual meeting in June 1972. These will apply to 1973 catch. Herring regulations are in effect in 1972.

The proposed regulations included the setting of international quotas for several species, allocated with preference to coastal state, more mesh regulations for cod, haddock, and flounder, and a minimum-size limit for scallops.

There was another innovation: including as part of quota allocations the catches of regulated stocks in international waters southwest of ICNAF convention regulation--ICNAF statistical Subarea 6.

HADDOCK

In 1971, total Subarea 5 landings were 12,169 metric tons, 169 MT above quota. U.S. fishermen landed 8,500 metric tons from Subarea 5, 14% below 1970. Landings from Georges Bank (ICNAF Division 5Z E) by New England fishermen were 7,301 metric tons, about 1,000 tons under 1970.

The annual 1970 fall groundfish survey by 'Albatross IV' revealed that the 1971 year-class was poor, continuing a trend begun in 1964. Recruitment of the fishery will continue much below average for at least two years (1972, 1973); abundance will remain at a very low level.

For 1972 and 1973, the Subarea 5 landings quota has been reduced to 6,000 metric tons, half the 1970-71 quota, but still too high to allow the stock to recover. Significant parts of Georges Bank will continue to be closed to groundfishing during March, April, and May. In 1974, the minimum mesh size for haddock amd cod will be increased from 4.5 to 5.1 inches (double manila standard). There was no national allocation of the haddock quota; however, countries other than the U.S. agreed essentially not to fish for haddock on Georges Bank.

YELLOWTAIL

In 1971, the reported yellowtail flounder catch in Subarea 5 was 30,629 MT. This exceeded the quota of 28,000 MT. The U.S. catch was 29,465, compared to 42,609 in 1970. The total catch reported for the Georges Bank area east of 69° was 15,698 MT, in southern New England and Cape Cod area 14,931 MT; the quotas were 16,000 MT and 12,000 MT, respectively. The catch on Cape Cod grounds was 2,351 MT.

U.S. commercial landings per day declined on both major fishing grounds (Georges Bank and southern New England). Survey cruise data from Albatross IV also indicate lower relative abundance and a below-average number of pre-recruits, particularly on southern New England grounds. Assessments suggest that abundance for 1972 will be somewhat below 1971.

Annual catch quotas for 1972 and 1973 have been set at 10,000 metric tons for southern New England (west of 69° W), 2,000 less than in 1971; and 16,000 metric tons for Georges Bank (east of 69° W), the same as 1971. The U. S. was allocated 92.3% of these quotas.

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The 'fish stocks' of the title are in ICNAF Subarea 5 & 6..

MARINE FISHERIES REVIEW
Reprint No. 953

COD

Total cod catch by all countries from Subarea 5 in 1971 was 35,357 metric tons, 34% taken by foreign countries.

U.S. landings from Georges Bank (ICNAF Division 5Z E) were 15,000 metric tons, slightly above 1970; while 1971 landings from other Subarea 5 grounds were 8,176 MT, slightly lower than 1970.

Survey-cruise and commercial fisheries studies indicate that abundance will probably remain at same level in 1972 and 1973.

ICNAF adopted for 1973 regulations for most cod stocks from Labrador to southern New England. Over 80% of cod catch in Northwest Atlantic will be under quota regulations. Assessment of the Georges Bank stock indicated that a maximum yield of 35,000 MT could be sustained. For Gulf of Maine, ICNAF recommended limiting catch to 10,000 MT, slightly above recent catches, to prevent potential overfishing. Both these values were proposed as quota regulations for 1973.

The U.S. allocation is 29,660 MT, or 66% (20,260) MT on Georges Bank; 9,400 MT in Gulf of Maine). This quota allows for a 1973 U. S. catch increase in Subarea 5of 6,485 tons over 1972 landings.

POLLOCK

In 1971, total U. S. landings of pollock from Subarea 5 were 4,727 metric tons, 1,135 tons above 1970; 3,037 metric tons were taken from Georges Bank. The catch by all countries was 14,311 metric tons.

There has been no definitive assessment study of the sustainable yields of the pollock stock but, most likely, it is much higher than present catch.

HERRING

In 1971, total Subarea 5 landings of herring were 268,063 metric tons, about 4% above 1970. U.S. landings from Gulf of Maine (ICNAF Division 5Y, the major U.S. fishing area) were 31,491 MT, 74% of 42,642 MT catch of all countries in Division 5Y. The juvenile catch was only 21% of 1971 total; prior to 1967, the catch was almost exclusively young fish (2- and 3-year-olds).

The last large year-class recruited to Gulf of Maine stock was that of 1961. Recruitment has been low and abundance down significantly in recent years. Abundance is expected to continue downward.

The Georges Bank-Middle Atlantic (ICNAF 5Z and 6) herring stock is under stress from overfishing. Effort has increased rapidly since 1967, while stock size has decreased. The 1971 catch was 267,374 MT, of which U. S. landings were 3,822 MT. Recruitment declined from 1964 through 1968. Current projections indicate poor abundance.

Because of herring's critical state, ICNAF enacted a quota system at a special meeting in January 1972. The 1972 quotas were 150,000 metric tons for Georges Bank-Middle Atlantic stock, and 30,000 metric tons for Gulf of Maine stock (excluding inshore sardine fishery). Both of these will serve to slow stock decline but are too high (especially former case) to stabilize stock size. The U.S. allocation was 21,000 MT for Gulf of Maine, and 5,000 MT for Georges Bank-Middle Atlantic stock.

A 9-inch minimum-size limit in all offshore areas was established. Also, Canada and the U.S. had agreed in 1971 to eliminate purse-seine fishery for one-year-old herring pursued to a large extent by Canada in Bay of Fundy.

SILVER HAKE (WHITING)

In 1971, total landings of whiting from SA 5 and 6 were 107,908 MT. U.S. landings of whiting from Subarea 5 were 13,332 metric tons, 31% below 1970. U.S. landings in Subarea 6 were 2.989 metric tons, about 700 MT above 1970. U.S. food-fish landings from Gulf of Maine and Georges Bank were 11,332 metric tons, 28% below 1970. Industrial landings of silver hake were 822 metric tons, down 398 tons from 1970.

The Gulf of Maine silver hake appears to be a separate stock from that in southern New England and Middle Atlantic. The status

of silver hake in eastern areas of Georges Bank is not clear. It appears to be separate from that to the southward and, at least during fishing season, distinct from those inshore.

The southern New England-Middle Atlantic stock appears in very good condition. It probably has benefited from reduced fishery caused by closed fishing area established by ICNAF, and the Polish and USSR bilateral agreements.

The eastern Georges Bank area appears in worse condition, while Gulf of Maine area is intermediate. In 1971, the U.S. catch from Gulf of Maine stock was 8,263 of a 8,316 total; the U.S. catch from other stocks was 8,058 MT of a 99,592 MT total.

Pre-recruit indices suggest improved incoming year-classes. These should support increased fishing in all areas for 1973 and 1974. The Gulf of Maine area particularly shows a significant increase for 1974 if too many small fish are not caught (mortality can be severe even if small fish are discarded).

ICNAF established quota regulations for 1973. The Gulf of Maine (Division 5Y) quota will be 10,000 MT, of which 9,500 is allocated to the U.S. This is an increase of 1,237 MT over 1971 U.S. landings from this area. The 5Z E area (Georges Bank, east of 70° line) and 5Z W-SA 6 area (southern New England and Middle Atlantic) each was assigned 80,000 MT quotas. Of this total, 42,000 MT were allocated to the U.S. This quota is five time the 1971 catch of 8,058 MT.

The regulated area in deep waters off southern New England will be closed during April in 1973, a change from the previous January through March closure.

REDFISH

In 1971, U.S. ocean perch (redfish) landings from New England waters were 16,267 metric tons, about 5% above 1970. Landings from Gulf of Maine, the principal U.S. ground, were 12,541 metric tons, down 1,000 tons from 1970. In 1971, catch of all countries in Subarea 5 was 20,034. The U.S. also caught 10,967 metric tons of redfish off Canada.

Landings per day continued to decline in 1971 on all but the Nova Scotia shelf, and abundance could be lower. Good catches still will be possible in most areas from 1972. The inshore closed area in Subarea 5 was modified to allow the redfish fishery to operate during March-May.

RED HAKE

In 1971, total red-hake landings off the U. S. were 39,937 metric tons, up 27,451 metric tons over 1970. U. S. landings were 3,604 in 1971 and 4,940 in 1970. Red hake on Georges Bank are still in low abundance, but moderate numbers are available from southern New England-Middle Atlantic stock. ICNAF adopted a quota of 40,000 metric tons for 1973, with 15,000 metric tons allocated to the U.S. for 5Z W-SA 6 area (southern New England-Middle Atlantic).

MIXED INDUSTRIAL FISHERY

In 1971, total New England landings of mixed industrial species were 11,412 metric tons, about 51% below 1970. Dockside samling of these catches indicate that red hake, silver hake, and ocean pout made up a larger percentage of 1971 landings than 1970; flounders, particularly yellowtail, contributed less in 1971.

SCALLOPS

The 1971 Georges Bank (Division 5Z) scallop landings were 5,230 MT total meat weight; U.S. vessels took 1,336 MT of these. The 1970 values were 5,504 MT and 1,421 MT. Catch per hour dragged by the Canadian fleet was 84 pounds, about the same as in 1970, but considerably below earlier years. The age at first capture has declined to 4 years for U.S. vessels and 3 years for Canadian, lower than the 5 years in previous years, or the 7 years that would give maximum sustainable yield. At its 1972 annual meeting, ICNAF adopted a minimum-size limit prohibiting retention of scallops less than 95 mm shell diameter, and an average meat count of 40 meats per pound or greater.

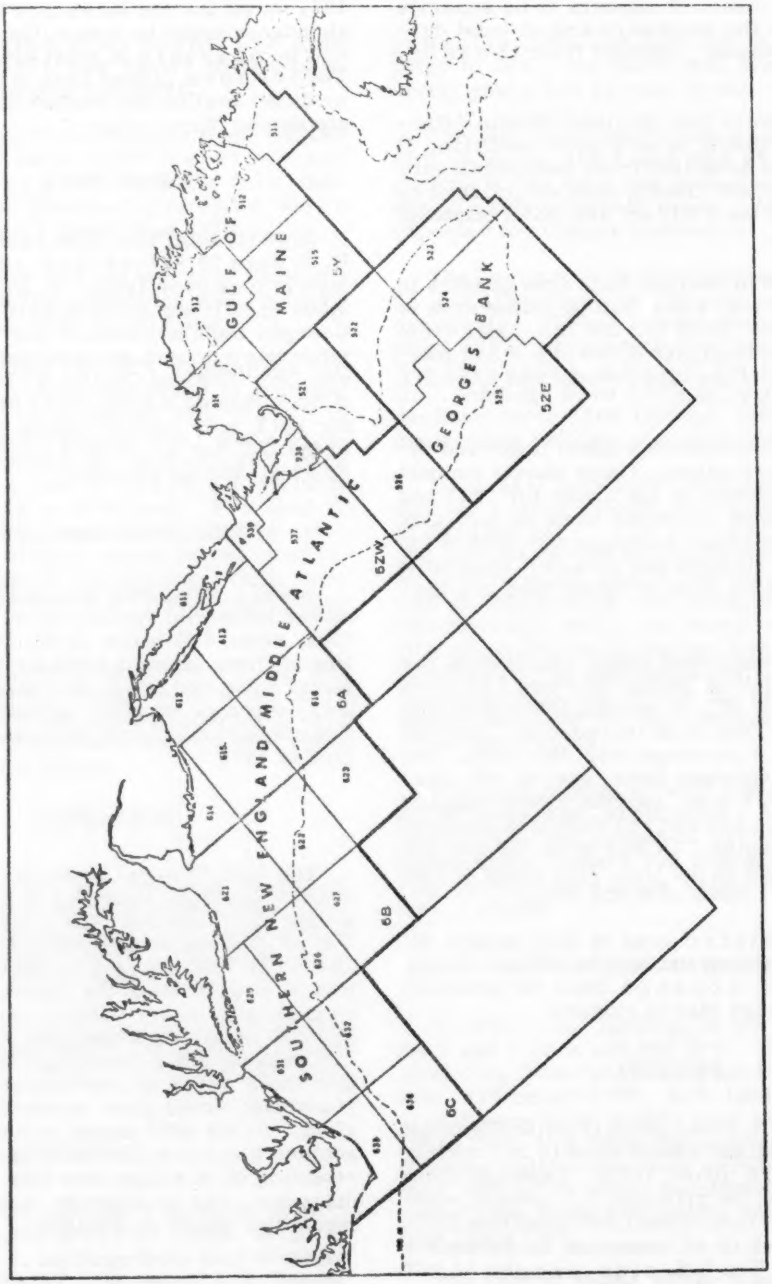
GULF OF MAINE
GEORGES BANK
SOUTHERN NEW ENGLAND
MIDDLE ATLANTIC
5Y
5ZE
5ZW
6A
6B
6C

TABLE 1. CATCHES (METRIC TONS) BY SPECIES AND COUNTRY FROM ICNAF SUBAREA 5 FOR 1971 AND (1970)

SPECIES	USA	CANADA	JAPAN	POLAND	ROMANIA	SPAIN	W.GERMANY	USSR	NON-MEMBER	TOTAL
Cod	23175	3098	20	155	6	7619	4	1270	10	35357
	(22347)	(2609)	(15)	(641)	(129)	(7249)	(14)	(364)	(-)	(38025)
Haddock	8500	1715	10	1	225	1337	4	374	3	12169
	(9872)	(2016)	(1)	(15)	(-)	(845)	(-)	(103)	(-)	(12856)
Redfish	16267	269	4	84	-	-	-	3394	16	20034
	(15534)	(338)	(19)	(30)	(35)	(-)	(-)	(-)	(115)	(16075)
Silver Hake	13332	-	103	136	390	-	-	81515	1658	97134
	(19379)	(-)	(74)	(15)	(113)	(-)	(2)	(28997)	(439)	(49017)
Red Hake	2783	-	-	-	-	-	-	25353	1463	29606
	(4281)	(-)	(-)	(-)	(-)	(-)	(-)	(6515)	(197)	(10993)
Herring	33890	20034	2434	69083	887	-	56467	63903	21365	268063
	(30484)	(5012)	(1223)	(54875)	(685)	(-)	(88221)	(39173)	(39268)	(258941)
Mackerel	1593	-	272	43682	1774	3	1175	59074	8867	116440
	(3092)	(-)	(463)	(40987)	(758)	(-)	(1004)	(56457)	(9006)	(111767)
Yellowtail Flounder	22341	105	3	-	-	-	-	925	131	23505
	(31920)	(75)	(-)	(-)	(-)	(-)	(-)	(2905)	(-)	(34900)
Winter Flounder	10435	62	-	-	-	-	-	1946	-	12443
	(11697)	(61)	(-)	(-)	(-)	(-)	(-)	(462)	(-)	(12220)
American Plaice	2170	40	2	1	499	-	-	340	-	3052
	(2586)	(87)	(-)	(-)	(688)	(-)	(-)	(945)	(-)	(4306)
Witch	3158	31	-	1	-	-	-	2713	-	5903
	(2959)	(15)	(-)	(-)	(-)	(-)	(-)	(108)	(-)	(3082)
Other Flounder	162	16	4	-	-	-	-	843	-	1025
	(307)	(19)	(119)	(8)	(107)	(-)	(-)	(-)	(87)	(647)
Cusk	783	1040	-	-	-	-	-	-	-	1823
	(552)	(813)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(1365)
Ocean Pout	2678	-	-	-	-	-	-	3553	-	6231
	(5851)	(-)	(-)	(-)	(-)	(-)	(-)	(895)	(-)	(6746)
Pollock	4727	1636	5	1	-	183	633	1163	5963	14311
	(3592)	(853)	(1)	(-)	(-)	(6)	(3156)	(51)	(-)	(7659)
Angler	88	-	-	-	-	5	-	3644	-	3737
	(201)	(-)	(-)	(-)	(-)	(-)	(-)	(477)	(-)	(678)

TABLE 1. CATCHES (METRIC TONS) BY SPECIES AND COUNTRY FROM ICNAF SUBAREA 5 FOR 1971 AND (1970) (CONTD)

SPECIES	USA	CANADA	JAPAN	POLAND	ROMANIA	SPAIN	W.GERMANY	USSR	NON-MEMBER	TOTAL
Sculpin	863	-	-	-	-	-	-	1095	-	1958
	(2608)	(-)	(-)	(-)	(-)	(-)	(-)	(2230)	(-)	(4838)
White Hake	2664	100	109	-	-	-	-	-	-	2873
	(1845)	(45)	(159)	(-)	(-)	(63)	(-)	(-)	(-)	(2113)
Bluefin Tuna	1123	424	-	2	-	-	1	-	-	1550
	(563)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(563)
Butterfish	419	-	973	-	-	-	-	400	1	1793
	(391)	(-)	(1723)	(-)	(-)	(-)	(-)	(396)	(-)	(2550)
Menhaden	6355	-	-	-	-	-	-	-	-	6355
	(5122)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(5122)
Atlantic Saury	-	-	-	-	-	-	-	2144	-	2144
	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(1054)	(-)	(1054)
Alewife	1005	-	-	1406	95	-	-	9014	3098	14618
	(1463)	(-)	(-)	(-)	(-)	(-)	(-)	(13135)	(75)	(14673)
Argentine	-	-	5398	-	-	-	-	1893	2	7293
	(-)	(-)	(369)	(-)	(-)	(-)	(-)	(999)	(-)	(1368)
Sharks	13	-	64	-	40	-	-	9045	-	9162
	(75)	(-)	(334)	(-)	(-)	(-)	(-)	(4336)	(-)	(4745)
Skates	741	2	-	-	-	-	-	3750	-	4493
	(1437)	(1)	(-)	(-)	(-)	(-)	(-)	(2544)	(14)	(3996)
Other Finfish	8036	334	1269	9137	1110	-	56	8930	2984	31856
	(6679)	(1352)	(660)	(5169)	(205)	(-)	(2)	(2965)	(14254)	(31285)
Scallops	14142	32434	-	-	-	-	-	-	-	46576
	(12938)	(34006)	(-)	(-)	(-)	(-)	(-)	(-)	(-)	(46944)
Other Shellfish	64664	102	4612	-	-	256	-	6473	80	76187
	(60335)	(-)	(5396)	(-)	(-)	(-)	(-)	(1065)	(-)	(66795)
TOTAL	246107	61442	15289	123689	5026	9147	58340	292754	45641	857691
	(258110)	(47303)	(10556)	(101740)	(2720)	(8163)	(92399)	(166176)	(68110)	(755277)
Total Finfish	167301	28906	10677	123689	5026	9147	58340	286281	45561	734928
	(184837)	(13297)	(5160)	(101740)	(2720)	(8163)	(92399)	(165111)	(68110)	(641537)
Total Shellfish	78806	32536	4612	-	-	256	-	6473	80	122763
	(73273)	(34006)	(5396)	(-)	(-)	(-)	(-)	(1065)	(-)	(113740)

TABLE 1. CATCHES (METRIC TONS) BY SPECIES AND COUNTRY FROM ICNAF SUBAREA 6 FOR 1971 AND (1970) (CONTD)

SPECIES	USA	CANADA	JAPAN	POLAND	ROMANIA	SPAIN	W.GERMANY	USSR	NON-MEMBER	TOTAL
Cod	383			101						484
	(364)			(143)						(507)
Haddock	8									8
	(2)									(2)
Silver Hake	2989		49	12	42			7061	621	10774
	(2248)		(256)	(-)	(-)			(3044)	(-)	(5548)
Red Hake	821		7					8285	1218	10331
	(659)		(-)					(834)	(-)	(1493)
Yellowtail Flounder	6867		7					829	125	7828
	(4050)		(3)					(1113)	(-)	(4164)
Other Flounder	3776		-					299	36	4111
	(4548)		(161)					(19)	(-)	(4728)
Ocean Pout	1448							186	2	1636
	(426)							(-)	(-)	(426)
Herring	1423		32	19242	11		-	17355	3890	41953
	(708)		(192)	(15859)	(-)		(356)	(22406)	(-)	(39527)
Mackerel	809		753	68612	5122		1621	68754	88958	234628
	(957)		(1037)	(27153)	(-)		(45)	(68026)	(-)	(97218)
Butterfish	1151		4795					86	25	6057
	(1478)		(6898)					(8)	(-)	(8324)
Menhaden	234396									234396
	(218304)									(218304)
Alewife	11799			819				2275	6320	21213
	(14888)			(-)				(5954)	(-)	(20842)
Sharks	89		76					2997		3162
	(169)		(325)					(588)		(1082)
Other Finfish	23734	567	856	7392	888			5354	6081	44872
	(27161)	(2084)	(1743)	(2226)	(-)			(1318)	(-)	(34532)
Scallops	7455									7455
	(8828)									(8828)
Other Shellfish	424195		5953					479	10	430637
	(442834)		(8314)					(-)	(-)	(451148)
TOTAL	721343	567	12528	96178	6063		1621	113960	107286	1059546
	(727624)	(2084)	(18935)	(45381)	(-)		(45)	(102308)	(-)	(896733)
Total Finfish	289693	567	6575	96178	6063		1621	113481	107276	621454
	(275962)	(2084)	(10621)	(45381)	(-)		(45)	(102308)	(-)	(436757)
Total Shellfish	431630	0	5953	-	-		-	479	10	438092
	(451662)	(0)	(8314)	(-)	(-)		(-)	(-)	(-)	(459976)

THE ATLANTIC COAST SURF CLAM FISHERY—1971

John W. Ropes, Allan M. Barker
and George E. Ward Jr.

The 1971 surf clam fishery produced landings of 51.6 million pounds of meats--23% less than in 1970. An increase in landings was recorded only for ports in Virginia. The establishment of ports there resulted in an increase in fleet size, but the number of vessels at all other ports declined.

FISHING AREAS

Cape May-Wildwood, New Jersey, Point Pleasant, New Jersey, and Ocean City, Maryland, were the major surf clam fishing areas in the Middle Atlantic Bight in 1971; Long Island, New York, and Virginia provided the remainder of the catch. The New Jersey fishery continued to supply most of the total landings, although the 35.6 million pounds landed were a smaller percentage (69%) than in 1970 (Table). Landings at Cape May-Wildwood were quadruple those at Point Pleasant.

Surf Clam Landings by Area (1971)

	Number of Vessels		Landings Millions of Lbs.	
	1970	1971	1970	1971
Cape May-Wildwood, N. J.	41	39	34.8	28.5
Ocean City, Md.	14	13	13.7	7.8
Point Pleasant, N. J.	21	17	13.2	7.1
Chincoteague to Norfolk, Va.	4	16	0.9	4.5
Long Island, N. Y.	7	7	4.2	3.7
Total	87	92	66.8	51.6

The areas fished by New Jersey boats in 1971 (Fig. 1) were similar to 1970 (Ropes and Barker, Marine Fisheries Review, Sept.-Oct. 1972). The Ocean City, Maryland, vessels worked more offshore beds than in 1970. The New York landings were taken off Long Beach and Fire Island. Vessels from Virginia ports fished offshore beds, although interviews begun in late 1971 were too few to determine their location accurately.

FLEETS AND METHODS

The New York fleet, based at Freeport, Long Island, remained at seven vessels. Five fished full time and two part time; the latter landed clams for fish bait. Average catch per trip for the full-time vessels was 205 bushels (3,485 pounds of meats). Total landings of 3.5 million pounds of meats for food and 0.2 million pounds for bait resulted from monthly landings of 181,000 to 408,000 pounds of meats (Fig. 2).

The Point Pleasant fleet decreased for the fifth consecutive year--the 17 vessels were four fewer than in 1970. Five Atlantic City boats were included in the 1971 total because some operated from both ports during the year and fished some of the same beds. Depths fished ranged from 9.1 to 36.0 meters (30 to 118 feet); the average depth was 21.6 meters (71 feet). Most vessels landed daily, but a few overnight trips were made to more distant grounds. Hours fished per boat-day ranged from 2.0 to 15.0. Monthly averages are shown in Figure 3. The average for 1971 was 9.1 hours, 0.1 less than in 1970.

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Fig. 1 - The area and intensity of surf clam fishing by the New Jersey, Maryland, and Chincoteague, Virginia, fleet in 1971 (based on 2,838 interviews).

The Cape May-Wildwood fleet decreased to 39--two vessels fewer than 1970. Two stern-dredgers began operating in 1971, bringing the total number of this type based at this port to five. Depths fished ranged from 5.5 to 36.0 meters (18 to 118 feet); average depth was 16.5 meters (54 feet). Most vessels landed daily, but some overnight trips were made tothe southern areas. Monthly averages of hours fished per boat-day are shown in Figure 3. Effort ranged from 2.0 to 19.0 hours. The average for 1971 was 7.9 hours, 0.8 hour higher than 1970. Seven vessels landed clams at Lewes, Delaware, in 1971; their landings were included in the Cape May-Wildwood total because five of the vessels were based at Wildwood and all of the clams came from areas fished by the Cape May-Wildwood fleet.

The Ocean City fleet decreased to 13 vessels--one less than in 1970. Depths fished ranged from 9.1 to 33.5 meters (30 to 110 feet); average depth was 19.2 meters (63 feet). Most vessels made daily trips and worked during daylight hours. Monthly averages of hours fished per boat-day ranged from 6.0 to 8.3. Daily effort ranged from 1.0 to 14.0 hours; the average was 7.5 hours (Fig. 3).

The Virginia fleet was based at Chincoteague, Wachapreague, Oyster, and Little Creek. The fleet size quadrupled from four in 1970. Average catch per trip was 452 bushels (7,684 pounds of meats). Total landings of 4.5 million pounds resulted from monthly landings varying from 21,000 to 996,000 pounds of meats (Fig. 2).

LANDING STATISTICS

Interviews by port samplers provided information on fishing areas and effort in New Jersey and Maryland. Landings in the Middle Atlantic Bight were supplied by the National Marine Fisheries Service, Division of Statistics and Market News.

Landings of 51.6 million pounds of meats were 15.2 million pounds (23%) lower than in 1970 (Table). Most of the decrease was due to lower landings by the Cape May-Wildwood and Point Pleasant, New Jersey, and Ocean City, Maryland, fleets. New Jersey produced 35.6 million pounds--12.4 million pounds

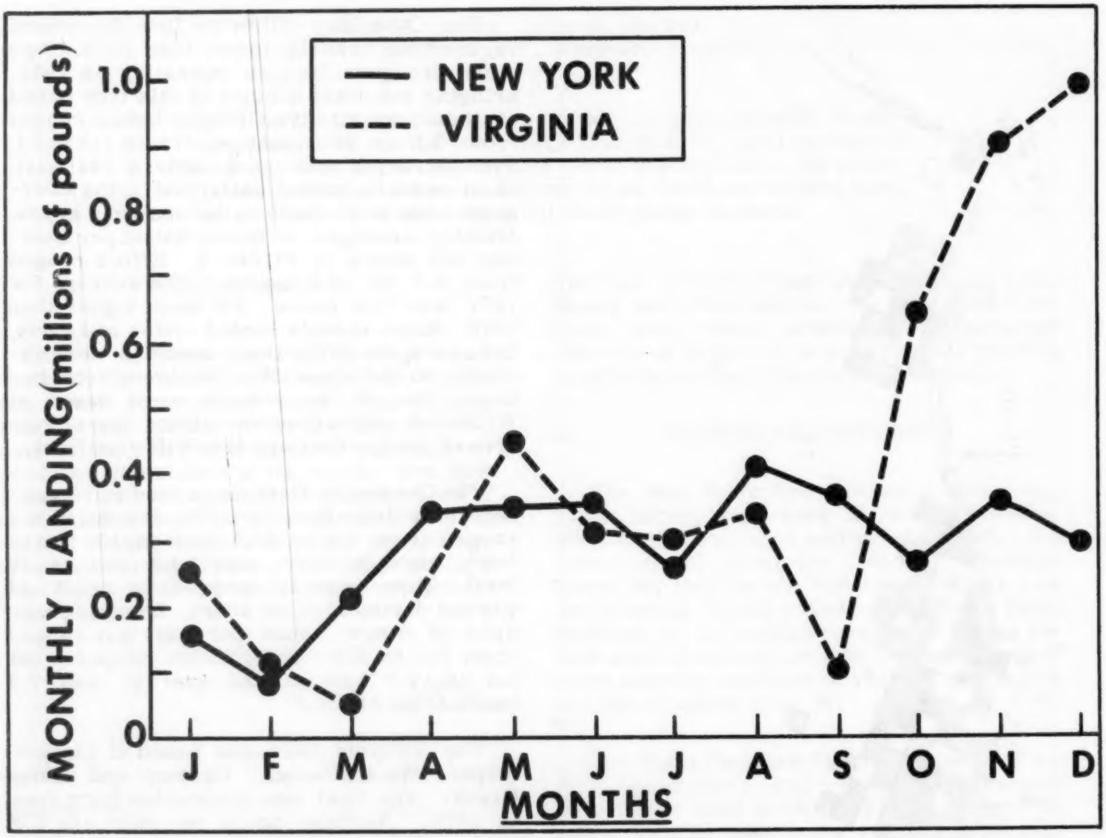

Fig. 2 - Monthly landings of surf clams at New York and Virginia, 1971.

(26%) fewer than in 1970. Maryland landings of 7.8 million pounds were lower by 43% (5.9 million pounds), and New York landings also decreased 12% (0.5 million pounds). Virginia landings showed the only increase (3.6 million pounds and 80% higher than in 1970). New Jersey landings were 69% of the 1971 total--Maryland, 15%; Virginia, 9%; and New York, 7%. In 1970, landings by the respective States were 72%, 21%, 1%, and 6%.

The Cape May-Wildwood fleet has provided more than half of the total New Jersey landings since 1967; in 1971, its contribution was 80% (28.5 million pounds) of the total (35.6 million pounds). Although the percentage landed at Cape May-Wildwood was greater, the weight of meats was less than in 1970 (34.8 million pounds).

At Cape May-Wildwood, landings per boat-day ranged from 55 to 1,052 bushels (935 to 17,884 pounds of meats) and averaged 269 bushels (4,573 pounds). The average in 1970 was 338 bushels (5,746 pounds). Monthly landings varied seasonally, with the catch declining when the boats moved offshore in good weather. Catch per hour decreased from 48 bushels (816 pounds) in 1970 to 34 bushels (578 pounds) in 1971. Figure 4 shows the catch per hour in the areas fished. The catch rate dropped sharply in May when the fleet moved offshore to fish for larger (150 mm) clams (Fig. 5). A total of 2,009 interviews were made in 1971; 46% of the trips were to inshore areas. Compared with 1970, this was a 21% decrease in trips made to inshore areas. The average catch per hour for inshore and offshore clams was 47 bushels

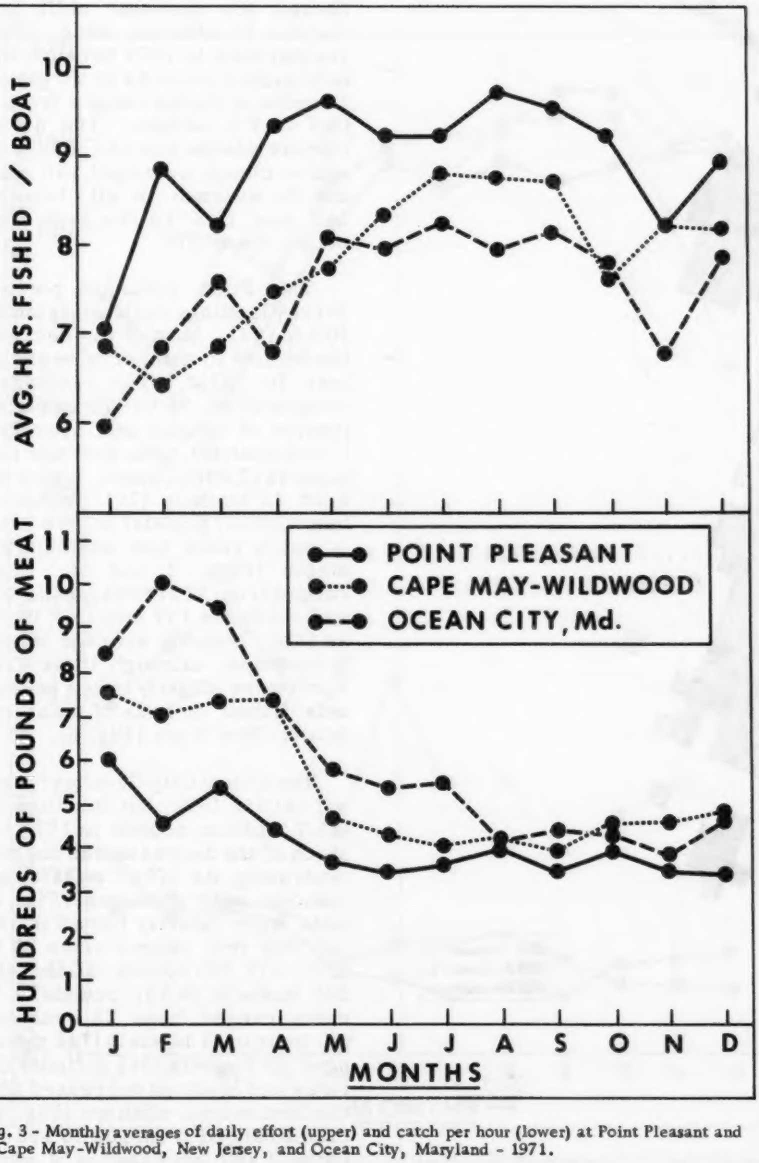

Fig. 3 - Monthly averages of daily effort (upper) and catch per hour (lower) at Point Pleasant and Cape May-Wildwood, New Jersey, and Ocean City, Maryland - 1971.

Fig. 4 - Catch per hour within the area fished by the New Jersey, Maryland, and Chincoteague, Virginia, fleet in 1971 (based on 2,838 interviews).

(799 pounds) and 25 bushels (425 pounds), respectively. Monthly average lengths reflected the seasonal shift in effort from inshore to offshore beds. The change was greater than in 1970 because the larger vessels moved to ports in Virginia after March. Lengths of clams ranged from 98 to 190 mm (3.9 to 7.5 inches). The average length of inshore clams was 129 mm (5.1 inches); offshore clams averaged 159 mm (6.3 inches); and the average for all clams measured was 143 mm (5.6 inches--6 mm (0.24 inch) larger than 1970.

The Point Pleasant portion of the New Jersey landings declined from 27% in 1970 to 20% in 1971. Most of the decrease was due to the decline in number of vessels (four vessels less in 1971). The landings per day-trip ranged from 55 to 472 bushels (935 to 8,024 pounds of meats) and averaged 208 bushels (3,536 pounds). The average in 1970 was 190 bushels (3,230 pounds). Catch per hour averaged 23 bushels (391 pounds) in 1971 and 21 bushels (357 pounds) in 1970 (Fig. 3). Monthly catch rates and landings were relatively stable (Figs. 3 and 5). Lengths of clams ranged from 110 to 184 mm (4.0 to 7.2 inches) and averaged 157 mm (6.2 inches), the same as 1970. Monthly average lengths were fairly constant, although those from January to April were slightly lower because some vessels fished on beds of small clams off Long Island, New York (Fig. 5).

The Ocean City fleet decreased by one vessel to 13 in 1971, but landings decreased 43% (13.7 million pounds in 1970 to 7.8 in 1971). Much of the decrease was due to the fleet concentrating its effort on offshore rather than inshore beds of clams (Fig. 2). The latter beds were heavily fished in 1970. Landings per day-trip ranged from 20 to 750 bushels (340 to 12,750 pounds of meats) and averaged 243 bushels (4,131 pounds). Monthly catch rates ranged from 23 bushels (391 pounds) per hour to 44 bushels (748 pounds) and averaged 33 bushels (561 pounds) (Fig. 3). Catch rates and landings decreased after April when the fleet moved offshore (Fig. 4). Lengths of clams ranged from 100 to 198 mm (3.9 to 7.8 inches) and averaged 151 mm (5.9 inches) (Fig. 5). Monthly average lengths varied with the seasonal shift of effort from inshore to offshore beds.

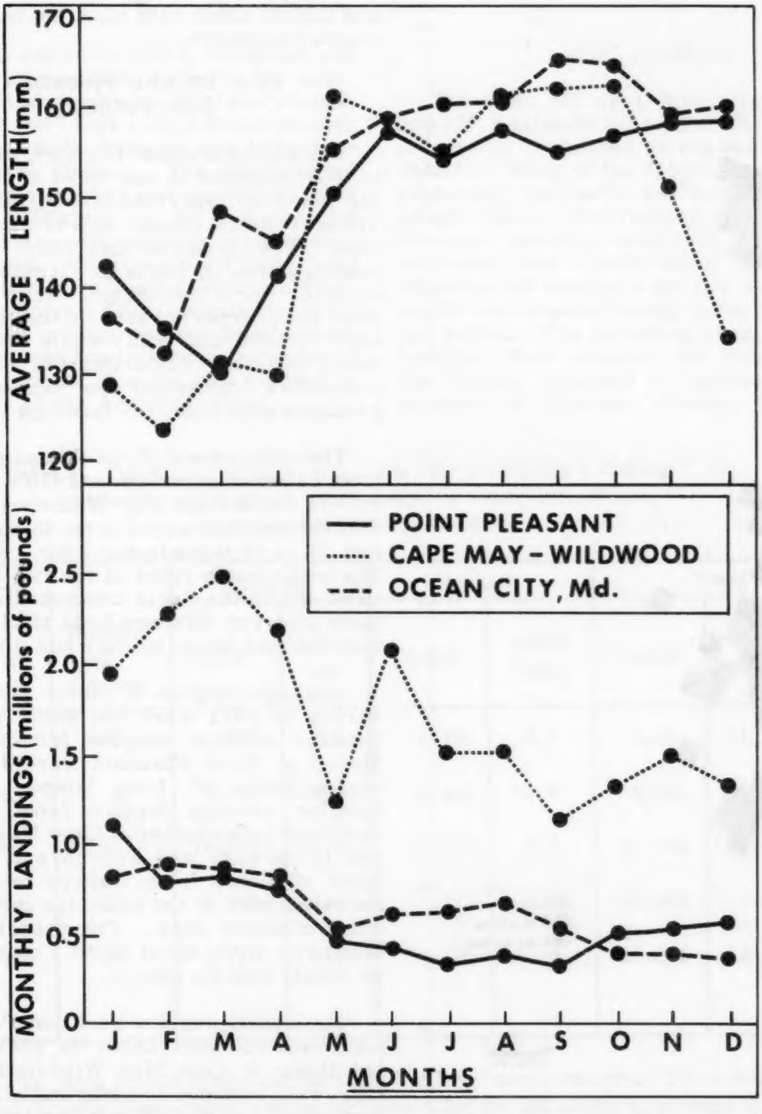

Fig. 5 - Monthly mean lengths of surf clams (upper) and landings (lower) at Point Pleasant and Cape May-Wildwood, New Jersey, and Ocean City, Maryland - 1971.

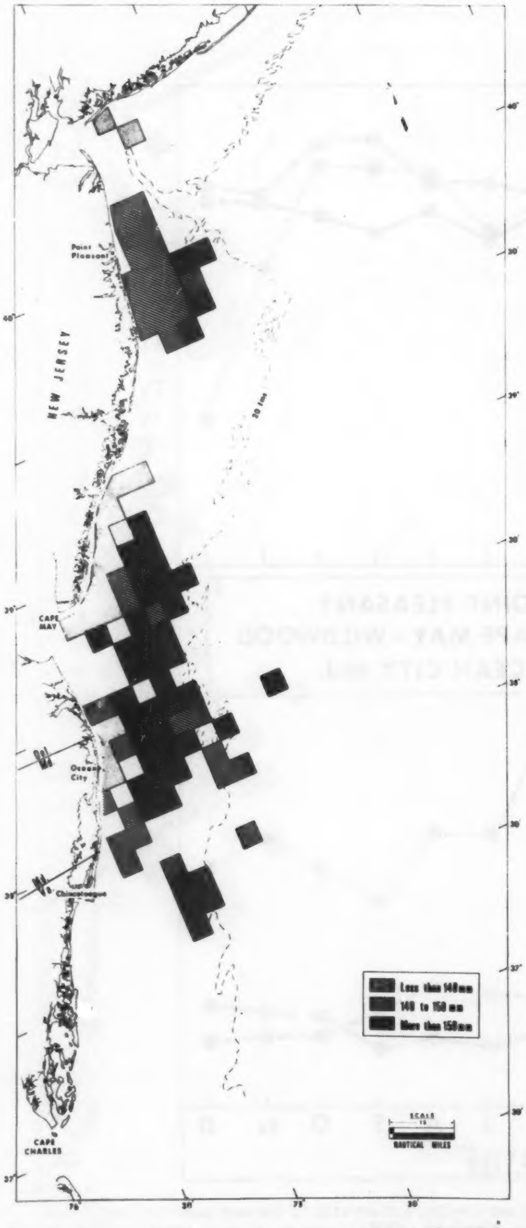

Fig. 6 - Average shell length of surf clams and area of catch by the New Jersey, Maryland, and Chincoteague, Virginia, fleet, 1971.

Figure 6 shows the average shell length and area of catch of surf clams in 1971. A comparison of this figure with Figures 1 and 4 clearly relates the greater number of trips and higher catch rate made on beds of small clams nearshore.

STATUS AND TRENDS OF THE FISHERY

The southward shift in effort, which started in 1967, resulted in one-third of the fleet using ports in Maryland and Virginia in 1971. These vessels caught 24% of the total landings. The greatest and only increase in landings was at ports in Virginia; landings at other ports decreased. High processing plant inventories created by the record landings in 1970 and unfavorable news reports about possible contamination of shellfish resources influenced the demand for clam products and, thus, the landings in 1971.

The catch rate at Point Pleasant increased from 21 bushels per hour in 1970 to 23 bushels in 1971, but at Cape May-Wildwood and Ocean City the rate decreased from 48 to 34 bushels and 53 to 33 bushels per hour, respectively. The lower catch rates at the two latter ports were due to the fleets concentrating more of their effort on offshore beds of clams rather than inshore beds, as they had done in 1970.

Average lengths of clams landed in New Jersey in 1971 were the same as in 1970. Smaller average lengths from January to March at Point Pleasant were due to small clams taken off Long Island, New York. Smaller average lengths from January to April and in December at Cape May-Wildwood and in January and February at Ocean City were of clams from inshore beds. During the remainder of the year, the landings were from offshore beds. The vessels from the latter two ports spent about 3 months fishing on small inshore clams.

The landings at New York and Point Pleasant should remain at about the present levels, but those at Cape May-Wildwood and Ocean City will continue to contribute the greatest portion of the total. Significantly large landings are expected at Virginia ports, and these will probably result in a grand total greater than that for 1971.

AMERICAN PARTICIPATION IN TUNA FISHERY OF EASTERN TROPICAL ATLANTIC

Gary T. Sakagawa and William H. Lenarz

In the 1950s and early 1960s, Canadian and United States tuna vessels fished in the eastern tropical Atlantic on an exploratory basis. It was not until 1967 that a significant number of American (Canada, Panama, and U.S.) vessels entered the fishery. The fleet started with three boats in 1967 and increased to 24 boats in 1971 (Table 1). All but one have been purse seiners with capacity greater than 400 metric tons. Their catches have been almost exclusively yellowfin (Thunnus albacares) and skipjack (Katsuwonus pelamis) tunas. This report reviews the development of the yellowfin and skipjack tuna fisheries of the eastern tropical Atlantic with respect to the operations of the American fleet.

THE FISHERY

The area off west Africa between 25° N and 25° S latitude and east of 25° W longitude (Figure 1) is defined as the eastern tropical Atlantic. Many of the Atlantic tropical tunas, especially yellowfin and skipjack tunas, are caught there. The fishery was a local, subsistence industry until 1955. Then, French baitboats that traditionally had fished for albacore off southern Europe ventured south to fish for tropical tunas in the Dakar, Senegal region. The following year the Japanese longline fleet entered the fishery. Today, the fishery consists of baitboats and purse seiners of Canada, France, Ivory Coast,

Table 1. Catch (metric tons) and catch rate (catch/day's fishing)[1/] of yellowfin and skipjack tunas caught by American seiners in the eastern tropical Atlantic

Year	Number of seiners	Yellowfin		Skipjack		Total	
		Catch	Catch rate	Catch	Catch rate	Catch	Catch rate
1967	3	978	7.6	473	3.7	1,451	11.3
1968	8	6,198	23.3	3,193	12.0	9,391	35.3
1969	25	19,845	10.9	4,440	2.4	24,285	13.3
1970	23	9,065	4.0	11,423	5.1	20,488	9.1
1971	24	3,750	2.5	16,875	10.3	20,625	12.8

[1/] Catch rates for the American fleet are for large purse seiners. The rates are not directly comparable to those in Table 4 for the FIS seiners, because the catch rates of the FIS seiners are based on total effort of large and small seiners, which have different fishing powers.

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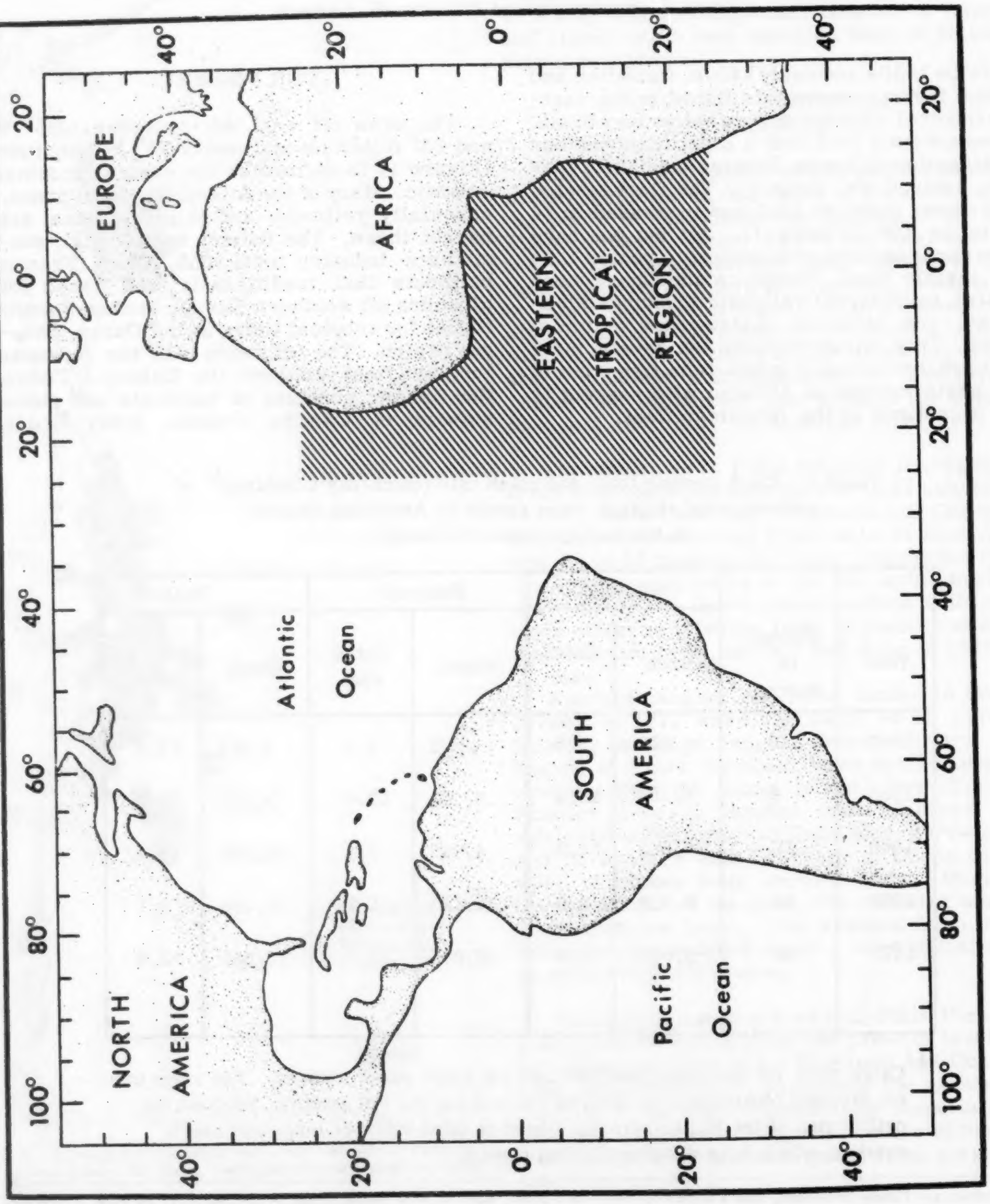

Fig. 1 - Map of the Atlantic Ocean showing the eastern tropical region.

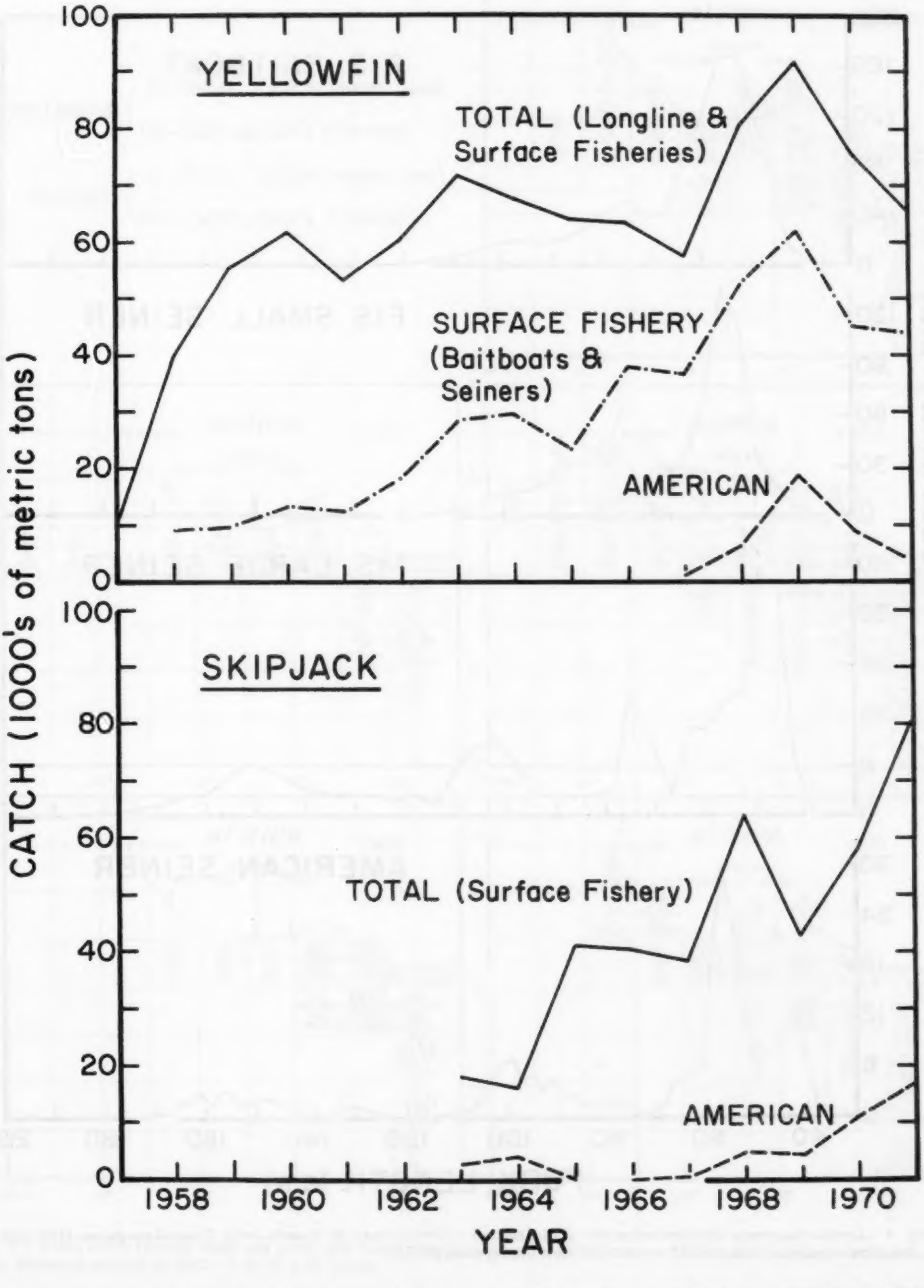

Fig. 2 - Catch of yellowfin and skipjack tunas from the Atlantic Ocean. Source of data is from Anonymous (1972).

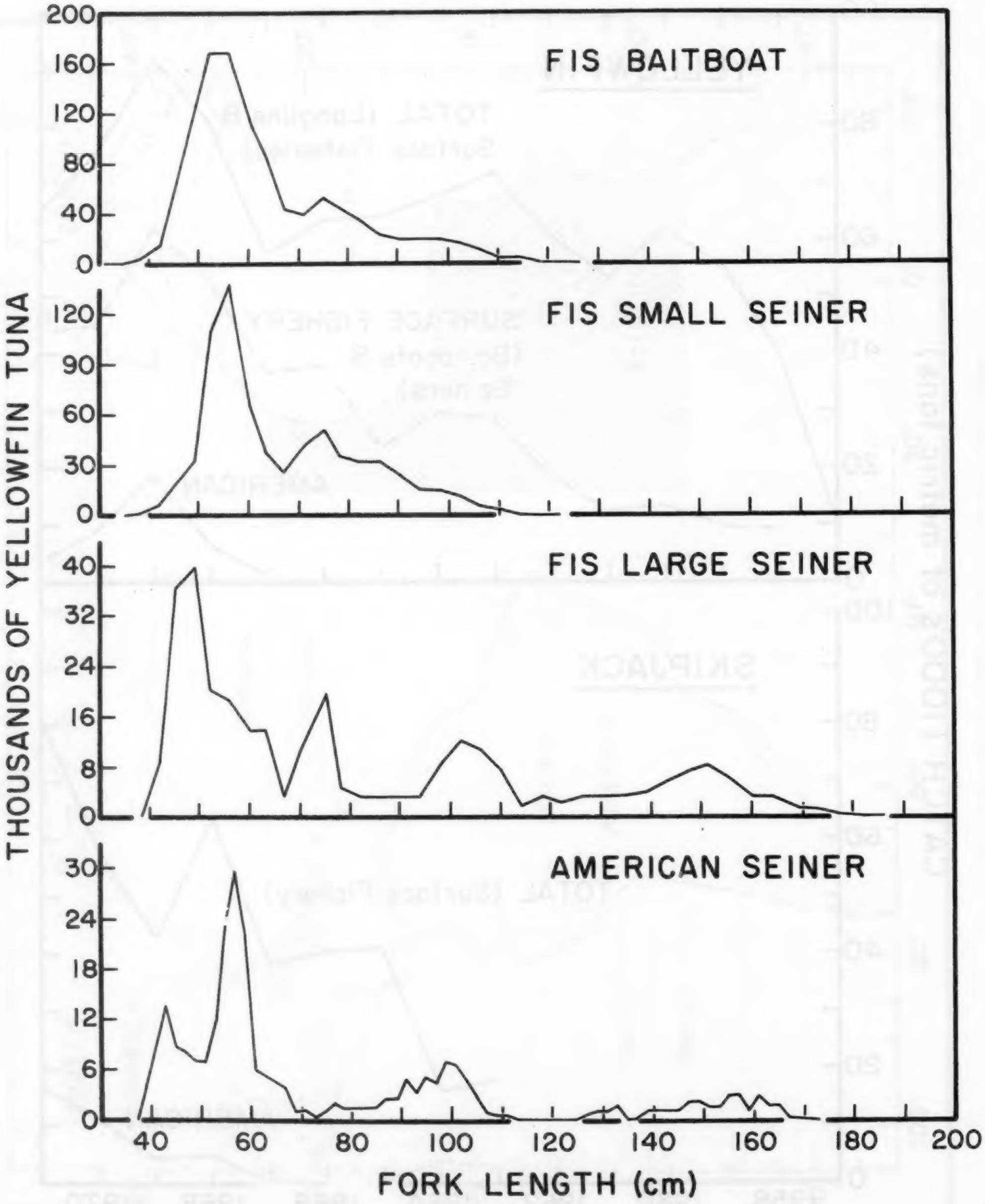

Fig. 3 - Length-frequency distribution of the 1971 catch of yellowfin tuna for French-Ivory Coast-Senegalese (FIS) and American vessels. Data for FIS vessels are from Anonymous (1972).

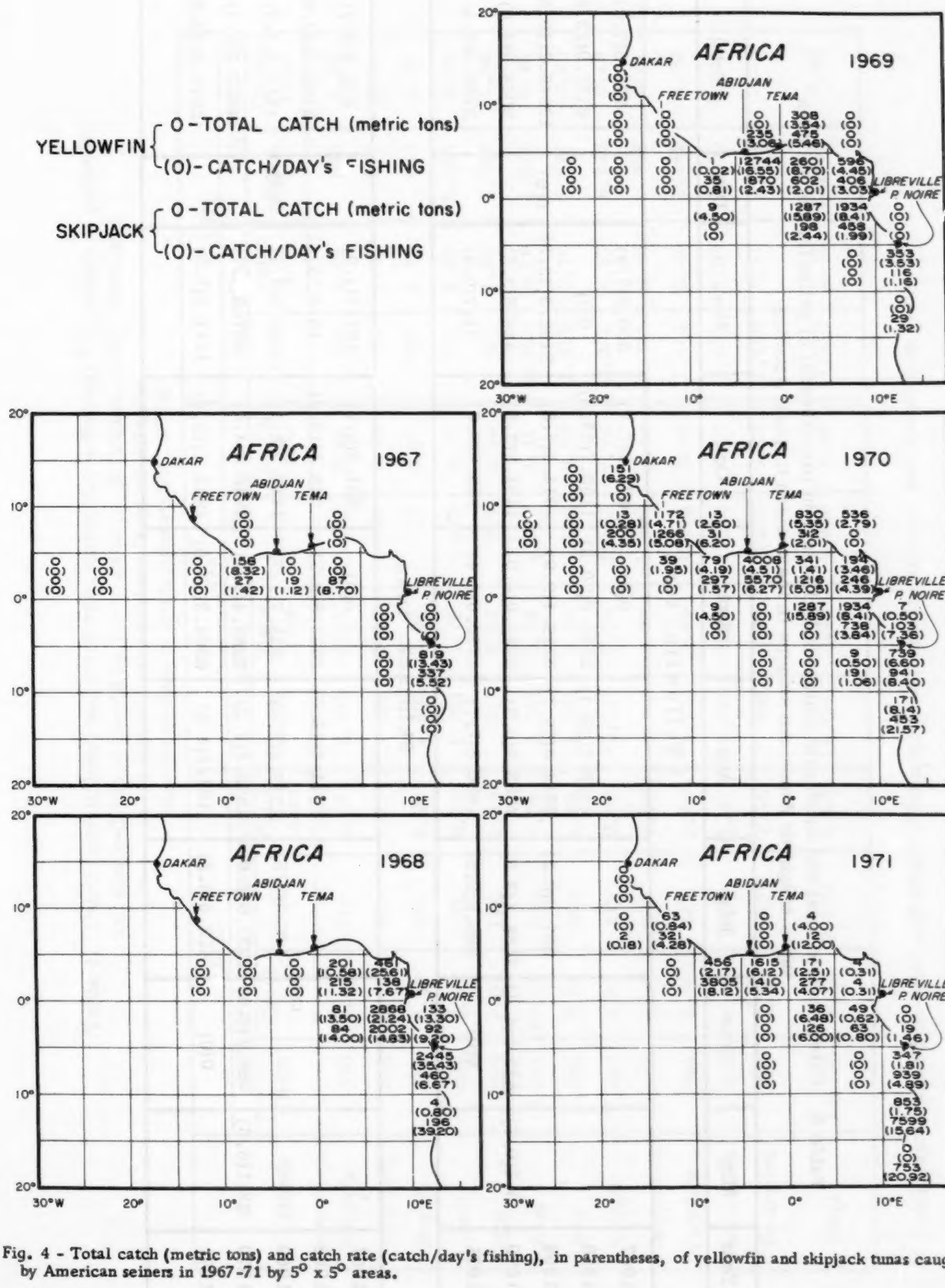

Fig. 4 - Total catch (metric tons) and catch rate (catch/day's fishing), in parentheses, of yellowfin and skipjack tunas caught by American seiners in 1967-71 by $5^{\circ} \times 5^{\circ}$ areas.

Table 3. Catch (metric tons) and catch rate (catch/day's fishing, in parentheses) of yellowfin and skipjack tunas caught by American seiners in the eastern tropical Atlantic

Year	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Total
Yellowfin tuna									
1967					0(0)	477.2(7.7)	500.3(7.9)		977.5(7.6)
1968				2122.2(29.1)	2910.0(20.3)	1165.7(23.8)	0(0)		6197.9(23.3)
1969			607.8(6.3)	6814.8(16.7)	5219.1(9.9)	4011.1(7.5)	3192.3(13.3)	0(0)	19845.2(10.9)
1970	3.6(0.7)	633.2(4.1)	1458.4(3.3)	2963.1(5.0)	2091.0(4.0)	1451.2(3.5)	464.5(3.5)		9064.9(4.0)
1971		0(0)	398.6(6.5)	1620.8(7.7)	1350.0(2.4)	298.9(0.6)	81.7(0.5)		3750.0(2.5)
Skipjack tuna									
1967					0(0)	351.5(5.7)	121.1(1.9)		472.6(3.7)
1968				1211.8(16.6)	1319.8(9.2)	646.4(13.2)	15.4(15.4)		3193.3(12.0)
1969			146.1(1.5)	2217.2(5.4)	918.7(1.7)	1113.0(2.1)	45.4(0.2)	0(0)	4440.3(2.4)
1970	28.1(5.6)	986.2(6.4)	1332.6(3.0)	4303.6(7.3)	2289.4(4.4)	1846.3(4.4)	637.3(4.7)		11423.4(5.1)
1971		0(0)	423.6(6.3)	1101.9(4.8)	6964.3(11.5)	6944.1(12.9)	1441.1(7.5)		16875.0(10.3)

Table 4. Catch (metric tons) and catch rate (catch/day's fishing) [1] by month of yellowfin and skipjack tunas caught by purse seiners of France, Ivory Coast and Senegal in the eastern tropical Atlantic (Source of data is from Anonymous, 1972)

Month	1969				1970				1971			
	Yellowfin		Skipjack		Yellowfin		Skipjack		Yellowfin		Skipjack	
	Catch	Catch rate	Catch	Catch rate	Catch	Catch rate	Catch	Catch rate	Catch	Catch rate	Catch	Catch rate
January	926	3.63	516	2.02	2,835	6.70	171	0.40	1,204	2.03	825	1.39
February	535	3.99	157	1.17	529	1.90	91	0.33	963	1.85	579	1.11
March	523	6.32	244	2.95	1,302	3.02	29	0.07	787	1.79	688	1.57
April	657	6.69	41	0.42	1,051	1.76	375	0.63	751	1.35	1,138	2.05
May	669	5.04	186	1.40	678	2.49	670	2.46	637	1.09	1,077	1.84
June	3,254	10.75	179	0.59	2,247	5.38	1,841	4.41	2,053	4.19	1,675	3.41
July	1,692	6.61	499	1.95	1,091	2.36	396	0.86	1,409	2.70	1,672	3.20
August	1,842	4.17	389	0.88	2,202	3.34	1,162	1.76	3,331	4.97	4,144	6.19
September	1,391	2.72	139	0.27	2,643	4.77	1,328	2.40	2,243	4.85	928	2.01
October	842	2.44	442	1.28	1,735	2.88	1,845	3.06	1,413	2.30	1,182	1.92
November	1,073	2.56	614	1.47	1,190	1.99	1,130	1.89	1,033	1.59	7,355	11.33
December	988	2.04	272	0.56	391	0.99	268	0.68	1,888	2.71	1,796	2.58
Total	14,392	4.16	3,678	1.06	17,894	3.14	9,306	1.64	17,712	2.61	23,059	3.39

[1] Catch rate is based on catch and effort of both large and small seiners. See footnote in Table 1.

Table 5. Catch (metric tons) and catch rate (catch/day's fishing), by month of yellowfin and skipjack tunas caught by baitboats of France, Ivory Coast and Senegal in the eastern tropical Atlantic (Source of data is from Anonymous, 1972)

	1969				1970				1971			
	Yellowfin		Skipjack		Yellowfin		Skipjack		Yellowfin		Skipjack	
Month	Catch	Catch rate	Catch	Catch rate	Catch	Catch rate	Catch	Catch rate	Catch	Catch rate	Catch	Catch rate
January	2,819	2.63	449	0.42	740	0.84	260	0.30	474	0.89	600	1.12
February	1,696	1.78	128	0.13	619	1.15	209	0.39	251	0.72	241	0.69
March	1,390	1.46	225	0.24	511	0.64	93	0.12	328	0.60	83	0.15
April	1,337	1.64	47	0.06	616	0.99	418	0.67	232	0.61	266	0.70
May	910	1.36	543	0.81	510	0.95	365	0.68	455	1.01	382	0.85
June	986	1.33	319	0.43	637	1.09	327	0.56	1,118	1.96	288	0.51
July	1,121	1.23	401	0.44	1,039	1.81	270	0.47	1,106	2.18	393	0.77
August	627	1.00	226	0.36	733	1.35	350	0.65	839	1.40	777	1.30
September	908	1.11	742	0.91	678	1.16	594	1.01	1,200	2.64	1,024	2.26
October	802	1.08	709	0.96	650	1.37	777	1.64	567	1.38	742	1.81
November	661	0.94	565	0.81	614	1.23	564	1.13	661	1.33	602	1.21
December	840	0.86	246	0.25	537	0.99	515	0.95	586	1.22	583	1.21
Total	14,097	1.41	4,600	0.46	7,884	1.10	4,742	0.66	7,817	1.35	5,981	1.03

Coast-Senegalese (FIS) baitboats and seiners are shown in Figure 3 (Anonymous, 1972). Fish caught by the American seiners are comparable in size to fish caught by FIS large seiners (> 400 metric tons capacity). They are different from sizes of fish caught by FIS baitboats and small seiners (< 400 metric tons capacity). The large seiners caught larger fish than the small seiners and baitboats. The reason is that large seiners use a larger and deeper net that catches the large, deep-swimming individuals of a school that fishing gears of small seiners or baitboats cannot catch.

Skipjack Tuna

The skipjack tuna resource of the Atlantic Ocean is considered to be large and underexploited (FAO, 1968). In the period 1965-71, the total annual catch averaged around 52,200 metric tons. The annual American catch prior to 1970 was under 5,000 metric tons. In 1970, the catch increased substantially to 11,400 metric tons, and to 16,900 metric tons in 1971. As with the American Atlantic catch of yellowfin tuna, most of the American Atlantic catch of skipjack tuna since 1966 has been from the eastern tropical region.

In American landings, the species mixture has changed from predominately yellowfin tuna in the 1960s to skipjack tuna in the 1970s (Table 2). This shift does not appear to be as pronounced in catches of other fleets that fished in eastern tropical Atlantic.

Table 6. Average catch rate (metric tons/day's fishing) of yellowfin and skipjack tuna for American purse seiners (1967-71) and French-Ivory Coast-Senegalese (FIS) purse seiners and baitboats (1969-71). The maximum catch rates are underlined

Month	Yellowfin			Skipjack		
	American seiner	FIS seiner	FIS baitboat	American seiner	FIS seiner	FIS baitboat
January	-	3.91	1.63	-	1.19	0.53
February	-	2.17	1.40	-	0.89	0.31
March	-	2.74	0.97	-	1.01	0.17
April	-	1.07	1.20	-	1.24	0.40
May	0.72	2.01	1.13	5.62	1.95	0.78
June	3.96	<u>6.24</u>	1.45	6.16	3.05	0.49
July	4.13	3.38	<u>1.64</u>	3.19	2.07	0.53
August	<u>10.11</u>	4.16	1.24	6.93	3.22	0.76
September	6.64	4.11	1.50	6.59	1.57	1.27
October	4.76	2.56	1.24	<u>7.00</u>	2.22	<u>1.37</u>
November	6.94	1.08	1.14	3.70	<u>5.46</u>	1.02
December	0	2.07	0.98	0	1.48	0.67

Japan, Norway, Panama, Portugal, Senegal, Spain, and the U.S.--and longliners of Korea, Japan, and Taiwan.

THE CATCHES

Yellowfin Tuna

In 1971, the total catch of yellowfin tuna from the Atlantic was 67,600 metric tons (Figure 2). This was lower than the high of 92,400 metric tons caught in 1969, and slightly lower than the 1961-70 average of 68,500 metric tons.

Since 1967, the American catch of Atlantic yellowfin tuna has been almost entirely from the eastern tropical Atlantic. The catch was 1,000 metric tons in 1967. It reached a high of 19,800 metric tons in 1969, dropped to 9,100 metric tons in 1970, and declined further to 3,800 metric tons in 1971 (Table 1). The decline in 1970 was due in part to a shift of fishing effort to skipjack tuna. The 1971 catch decline probably was due to a combination of decreased yellowfin fishing effort and increased availability of skipjack tuna.

The sizes of yellowfin tuna caught in 1971 by the American seners and French-Ivory

Table 2. Proportion of yellowfin and skipjack tunas in the combined catch (metric tons) of both species from the eastern tropical Atlantic

Nation and type of vessel	Year	Yellowfin Catch		Skipjack Catch		Total	
		Catch	%	Catch	%	Catch	%
French	1969	26,370	77.0	7,855	23.0	34,225	100
baitboat and	1970	21,400	65.1	11,449	34.9	32,849	100
purse seiner	1971	20,091	56.1	15,722	43.9	35,813	100
Ivory Coast							
baitboat and	1970	590	58.9	412	41.1	1,002	100
purse seiner	1971	1,126	57.0	848	43.0	1,974	100
Japanese	1963	900	8.9	9,200	91.1	10,100	100
baitboat	1964	2,600	45.6	3,100	54.4	5,700	100
and two-boat	1965	2,400	22.9	8,100	77.1	10,500	100
purse seiner	1966	5,300	47.7	5,800	52.3	11,100	100
	1967	6,500	52.4	5,900	47.6	12,400	100
	1968	7,900	36.7	13,600	63.3	21,500	100
	1969	6,800	53.5	5,900	46.5	12,700	100
	1970	2,400	24.2	7,500	75.8	9,900	100
	1971	5,300	26.5	14,700	73.5	20,000	100
Senegalese	1969	2,519	79.6	645	20.4	3,164	100
baitboat and	1970	4,000	65.7	2,091	34.3	6,091	100
purse seiner	1971	4,676	61.9	2,880	38.1	7,556	100
American	1967	978	67.4	473	32.6	1,451	100
purse seiner	1968	6,198	66.0	3,193	34.0	9,391	100
	1969	19,845	81.7	4,440	18.3	24,285	100
	1970	9,065	44.2	11,423	55.8	20,488	100
	1971	3,750	18.2	16,875	81.8	20,625	100

LIMITED FISHING SEASON

Although tuna vessels of other nations, France and Spain, for example, fish in the eastern tropical Atlantic most of the year, the American fleet has fished there only during summer and fall (Table 3). The season for the American fleet is dictated largely by events in the eastern tropical Pacific. Most boats of the American fleet are based in California. They fish the eastern tropical Pacific from January until the yellowfin tuna catch quota is reached (Joseph, 1970). Since the catch rates in the eastern tropical Pacific are high, there has not been any incentive for the American boats to fish the more distant fishing grounds in the Atlantic before the close of the yellowfin season in the eastern Pacific.

The peak season (1967-71) for the American fleet has been August to November (Table 3). Peak season (1969-71) for the FIS fleet (baitboats and seiners) that fish year round has been summer and fall (Tables 4 and 5). Therefore, it appears that the American fleet is fishing during the period when yellowfin and skipjack tunas are most available in the areas presently being fished.

FISHING AREAS & CATCH RATES

The catch and catch rate for 1967-71 by $5^{\circ} \times 5^{\circ}$ areas for the American fleet are shown in Figure 4. The distribution of catches indicates that yellowfin and skipjack tunas are caught close inshore; most of the catch is made in the Gulf of Guinea. In 1971, a substantial amount of skipjack tuna also was caught off Angola. That was the first year in which the American fleet fished heavily (about 711 day's fishing) off Angola (south of 10° S); all its effort was concentrated in September and October. The results, therefore, cannot be judged at this time as typical for areas off Angola.

The catch rates for $5^{\circ} \times 5^{\circ}$ areas range from 0-34 metric tons/day's fishing for yellowfin tuna and 0-39 metric tons/day's fishing for skipjack tuna. The higher rates generally are associated with areas of low fishing effort. However, for some areas, such as off Angola in 1971 and off the Ivory Coast in 1969, the catch rate was high even when the fishing effort was high.

Discussion

There is some evidence--decreasing catch per unit of effort with increase in effort, and smaller average sizes of fish in the catch--that suggests that the total catch of yellowfin tuna from the eastern tropical Atlantic would not increase appreciably if fishing effort is increased within the areas presently fished by each type of vessel (Anonymous, 1972). However, if the distribution of yellowfin tuna in the Atlantic is similar to that in the Pacific, the catch might presumably increase if the surface fishery (baitboats and seiners) is extended farther offshore into areas presently fished only by longliners.

From the point of fishing strategy of the American fleet, the question might be raised whether extending the fishing season would result is an appreciable increase in the fleet's catch and catch rate. Results for the FIS fleet suggest that this is possible (Tables 4 and 5). Most of the French catch of yellowfin and skipjack tunas are made during June to January, and the catch rates are relatively high (Table 6). On the other hand, the American catch and effort are concentrated in August to November. Thus, if the American fleet extends its fishing season into December and January, the fleet's total catch and catch rate probably would be increased.

Acknowledgments

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HOW SOME POLLUTANTS AFFECT EMBRYOS & LARVAE OF AMERICAN OYSTER & HARD-SHELL CLAM

Anthony Calabrese

This article reports the effects of detergents, pH, and pesticides on development of embryos and survival and growth of larvae of the American oyster and hard-shell clam. Although LAS detergents are more readily biodegraded than ABS detergents, results indicate that the former are at least as toxic to oyster larvae as ABS compounds. For successful recruitment of clams and oysters, the pH of estuarine waters must not fall below 7.00 for clams or 6.75 for oysters. Neither species could reproduce successfully in waters where the pH remained appreciably above 9.00. Most of the pesticides tested affected embryonic development more than survival or growth of larvae. Some, however, drastically reduced growth of larvae at concentrations that had relatively little effect on embryonic development.

The effects of pollutants on mollusks and on the survival and growth of their larvae are of interest to biologists and of considerable importance to shellfish producers. Since several of the most important commercial species are essentially inhabitants of the shallow waters of bays and estuaries, almost all grounds used for cultivation of shellfish are frequently subjected to both domestic and industrial pollutants. Scientists at the NMFS Milford (Conn.) laboratory have studied the effects of various pollutants on development of embryos and survival and growth of larvae of the American oyster, Crassostrea virginica, and the hard-shell clam, Mercenaria mercenaria. The effects of detergents, pH, and pesticides were especially studied.

METHODS

In all these experiments, a standard procedure for determining the effects of pollutants was used. To determine the effects of various pollutant concentrations on the development of bivalve embryos into normal, straight-hinge larvae, about 13,000 embryos were placed into each of a series of 1-liter beakers. To determine the effects of the same conditions on survival and growth of larvae, usually 8,000 to 12,000 larvae reared to the 48-hour straight-hinge stage under normal conditions were placed into 1-liter beakers. Duplicate cultures were maintained at each concentration of the pollutant, and two cultures were left untreated as controls. The beaker cultures with larvae were changed every second day for 10 to 12 days to eliminate metabolic waste products, and the experimental conditions were reestablished. Supplemental food was added daily and, in some experiments, 50 mg/1 of Sulmet were added to each culture every second day to minimize mortality due to factors other than toxicity of the pollutant.

The effects of the pollutants on embryonic development were determined by taking a 4/250 ml aliquot of the total sample after 48 hours. The number of embryos developing normally was counted and the results expressed as a percentage of the number developing in the controls. To determine percentage of survival and increase in size of larvae, the cultures were sampled quantitatively in a manner similar to the experiments with embryos. Survival was expressed as a percentage of survival in the controls, and increase in size was determined as a percentage of the increase in mean length of larvae in the control cultures.

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DETERGENT STUDIES

An industry-wide conversion from the alkyl benzene sulfonate (ABS) type detergents, which are only very slowly degraded by bacterial action, to the biodegradable linear alkylate sulfonate (LAS) type detergents was completed on June 30, 1965. Since these detergents are almost completely degraded in an efficient sewage-treatment plant, most of the detergent will occur in the effluent as degradation products, rather than as active detergent.

A study of detergents determined the toxicity to oyster embryos and larvae of a reference sample of undegraded LAS and a commercial liquid biodegradable detergent (1). The sample of LAS contained 60.8% active LAS; the liquid detergent was of unknown composition. Test concentrations were from 0.0025 to 2.5 mg/1. For tests of degradation products of LAS, effluents were obtained from the U.S. Testing Company in which almost 100% of the 20.0 mg/1 of added LAS had been degraded. Control effluent that contained no detergent degradation products was also used. Liter cultures were set up with effluent containing degradation products equivalent to original LAS concentrations of 0.1, 0.2, 2.0, 3.0, 4.0, and 5.0 mg/1. This meant that it was necessary to add 5, 10, 100, 150, 200, and 250 ml of effluent, respectively. Another series of cultures was set up with equivalent volumes of effluent that contained no detergent degradation products to determine whether the degraded products of the detergents of the effluent affected the embryos and larvae.

Oyster embryos had a very low tolerance to active LAS detergents (Table 1). A concentration of 0.10 mg/1 permitted only 64% of the embryos to develop and many of them were abnormal either in shape or size. Development of 47% was reached at 0.50 mg/1 of ABS, which was 54.8% active (2). It would appear that LAS is somewhat more toxic than ABS while in the active state. In experiments with the commercial liquid biodegradable detergent, oyster embryos tolerated a concentration up to 0.25 mg/1 of the gross product. The percentage of active LAS in this product was not known; therefore, it is quite probable that its lower toxicity was the result of a lower concentration of active LAS. Embryos developed at a concentration as high as 1.0 mg/1 using the similar brand product with an ABS base; again this indicated that LAS is somewhat more toxic than ABS while in its active state.

The sewage-treatment effluent, both with and without degraded LAS, had about the same toxicity. Even though a comparatively high percentage of embryos developed at a concentration of 5.0 mg/1, many larvae were abnormal. Cultures treated with active LAS were compared with those treated with sewage effluent containing either no LAS or degraded LAS. It was apparent that the LAS had lost most of its toxicity through degradation treatment. Any remaining toxicity of the LAS or its degraded products was marked by the toxicity of the effluent itself.

Oyster larvae were somewhat more tolerant to both standard LAS and the commercial product than the embryos (Table 2). A significant reduction in survival of larvae occurred at concentrations of 0.5 to 1.0 mg/1 for the LAS and between 1.0 to 2.5 mg/1 for the commercial product. Although the percentage survival of larvae in the control cultures was somewhat greater than in cultures receiving the effluent, with or without degraded LAS, it required a degradation product concentration equivalent to 4.0 mg/1 of the undegraded LAS before a drastic reduction in survival occurred. The similarity of results of effluent with and without detergent degradation products suggested that the toxicity was primarily that of the effluent itself.

As indicated by the percentage of increase in mean length, growth of oyster larvae was normal at LAS concentrations of 0.0025 to 0.25 mg/1, but showed a very sharp break between 0.25 mg/1 and 0.5 mg/1 of active LAS (Table 3). The liquid detergent was somewhat less toxic, but a decline in growth of larvae occurred between detergent concentrations of 1.0 and 2.5 mg/1. It should be remembered, however, that the percentage of active LAS in this commercial detergent was not available, and the lesser toxicity probably was due to a lower concentration of active LAS. Approximately normal growth of larvae was achieved at concentrations up to 2.0 mg/1 in both the control sewage effluent and that containing degraded LAS. Slight growth did occur at a degradation product concentration equivalent to 4.0 mg/1 of undegraded LAS in the cultures receiving effluent with degraded LAS.

We found that effluent containing LAS degradation products equivalent 20.0 mg/1 of LAS is little, if any, more toxic to oyster embryos and larvae than an equal volume of effluent containing no such degradation products. From these experiments it seems apparent that, if sewage-treatment plants are effective, it would be necessary to introduce enough effluent to constitute 15% or more of the total volume of a body of water to affect the development, survival, and growth of oyster larvae seriously. In most areas, this is probably a higher concentration of effluent than would normally be present. But in some areas, where sewage effluent approaches 15% of the total volume of the body of water it enters, it could be expected to affect recruitment of oysters.

pH STUDIES

The tidal estuarine waters that form the principal habitat of most commercial mollusks is one of the most complex environments in nature. Yet of the various interacting biological, physical, and chemical factors affecting commercial mollusks, pH has received less attention than any other major factor. While the pH of the open ocean usually ranges from 7.5 to 8.5, the pH in tidepools, bays, and estuaries may decrease to 7.0 or lower due to dilution, H_2S production, and pollution (3). Since clam and oyster larvae must, at times, encounter a wide range of pH in their natural habitat, it is possible that success or failure of recruitment of these mollusks in some areas may be determined by variations in pH. With this in mind, a study was initiated to determine the effect of pH on embryos and larvae of clams and oysters (4).

The experimental setup was described before, but in this case the pH levels in the beaker cultures were adjusted from 6.0 to 9.5 by the addition of HCl or NaOH.

There was no significant decrease in the number of clam embryos developing normally within the pH range from 7.0 to 8.75 or of oyster embryos from pH 6.75 to 8.75 (Fig. 1). The number of both clam and oyster embryos developing normally at pH 9.0 was greatly reduced, and at pH 9.25 to 9.5 there was virtually no development. Clam embryos apparently were not able to tolerate as low a pH as did oyster embryos: at pH 6.75, more than three times as many oyster embryos as clam embryos developed normally.

Both clam and oyster larvae showed about normal survival throughout the pH range from 6.25 to 8.75 (Fig. 2). Oyster larvae, however, were somewhat more tolerant of low pH levels than clam larvae. At pH 6.0, for example, 21.5% of the oyster larvae survived, but none of the clam larvae. At pH 9.0, some larvae lived for a few days and showed some growth, although eventually more than 50% died; at 9.25 and higher, there was no survival of either species.

The pH range for normal growth of clam larvae was 6.75 to 8.50 and for oyster larvae 6.75 to 8.75 (Fig. 3). The pH range for normal growth was, therefore, slightly narrower than that for normal survival. The rate of growth of clam larvae was most rapid at pH 7.5 to 8.0, while oyster larvae grew most rapidly at pH 8.25 to 8.5. Although oyster embryos and larvae survive at lower pH levels than clam embryos and larvae, the optimum pH for growth of oyster larvae is somewhat higher than the optimum for clam larvae. The rate of growth decreased rapidly below 6.75 and above pH 8.75 for both clams and oysters.

It should be emphasized that clam larvae can survive at pH 6.25, which is lower than the pH 7.0 at which clam embryos develop normally; but at pH levels below 7.0 failure of clam embryos to develop normally would be the factor that would limit recruitment of this species (Fig. 4). The percentage of clam embryos developing normally, larval survival, and increase in mean length all decrease precipitously at about pH 9.0; these three factors would limit recruitment of this species.

Oyster larvae, like clam larvae, can survive at lower pH levels than those at which embryos can develop. At pH 6.25, there was a sharp increase in the survival of oyster larvae and only a negligible increase in development of oyster embryos (Fig. 5).

In experiments with adult oysters (5), it was concluded that the minimum and maximum pH levels at which they would spawn are 6.0 and 10.0, respectively. The percentage of oysters that spawned at pH 6.0 and 10.0 was considerably lower than the percentage that spawned at the normal pH (7.8) of laboratory sea water. In all tests, male oysters spawned more readily than females,

TABLE 1. Percentage of oyster eggs developing to straight-hinge larvae in various concentrations of LAS detergent and sewage effluent /after (1)/.

Concentration (mg/l)	LAS[1]	Liquid biodegradable[2] detergent	Effluent with degraded LAS	Effluent[3] without degraded LAS	Volume of effluent (ml/l)
0.0 (Controls)	100	100	100	100	0 (Controls)
0.0025	92	99	-	-	-
0.005	88	108	-	-	-
0.010	85	108	-	-	-
0.025	66	118	-	-	-
0.05	51[4]	115	-	-	-
0.10	64[4]	68	-	-	-
0.20	-	-	127	78	10
0.25	0	63	-	-	-
0.50	0	14	-	-	-
1.00	0	0	-	-	-
2.00	-	-	97	109	100
2.50	0	0	-	-	-
3.00	-	-	-	-	-
4.00	-	-	-	-	-
5.00	0	0	99[4]	66[4]	250
10.00	0	0	-	-	-

1 Concentrations listed are of active LAS; gross product contained 60.8% active LAS

2 Concentrations listed are of gross product; percentage of active LAS unknown

3 Values listed based on single experiment

4 Many larvae in these cultures abnormal in size or shape, or both

TABLE 2. Percentage of oyster larvae surviving in various concentrations of LAS detergent and sewage effluent /after (1)/.

Concentration (mg/l)	LAS[1]	Liquid biodegradable[2] detergent	Effluent with degraded LAS	Effluent[3] without degraded LAS	Volume of effluent (ml/l)
0.0 (Controls)	100	100	100	100	0 (Controls)
0.0025	76	96	-	-	-
0.005	106	88	-	-	-
0.010	93	102	-	-	-
0.025	71	104	-	-	-
0.05	96	84	-	-	-
0.10	104	120	78	-	5
0.20	-	-	76	75	10
0.25	95	95	-	-	-
0.50	63	82	-	-	-
1.00	0	87	-	-	-
2.00	-	-	69	103	100
2.50	0	42	-	-	-
3.00	-	-	63	-	150
4.00	-	-	35	-	200
5.00	0	0	10	19	250
10.00	0	0	-	-	-

[1] Concentrations listed are of active LAS; gross product contained 60.8% active LAS

[2] Concentrations listed are of gross product; percentage of active LAS unknown

[3] Values listed based on single experiment

TABLE 3. Percentage increase in mean length of oyster larvae reared in various concentrations of LAS detergent and sewage effluent /after (1)/.

Concentration (mg/l)	LAS[1]	Liquid biodegradable[2] detergent	Effluent with degraded LAS	Effluent[3] without degraded LAS	Volume of effluent (ml/l)
0.0 (Controls)	100	100	100	100	0 (Controls)
0.0025	96	100	-	-	-
0.005	97	101	-	-	-
0.010	98	101	-	-	-
0.025	106	100	-	-	-
0.05	94	102	-	-	-
0.10	96	103	111	-	5
0.20	-	-	105	92	10
0.25	88	101	-	-	-
0.50	31	103	-	-	-
1.00	Dead	100	-	-	-
2.00	-	-	85	71	100
2.50	Dead	44	-	-	-
3.00	-	-	55	-	150
4.00	-	-	32	-	200
5.00	Dead	Dead	-[4]	-[4]	250
10.00	Dead	Dead	-	-	-

1 Concentrations listed are of active LAS; gross product contained 60.8% active LAS

2 Concentrations listed are of gross product; percentage of active LAS unknown

3 Values listed based on single experiment

4 Number surviving too small for accurate determination of mean length

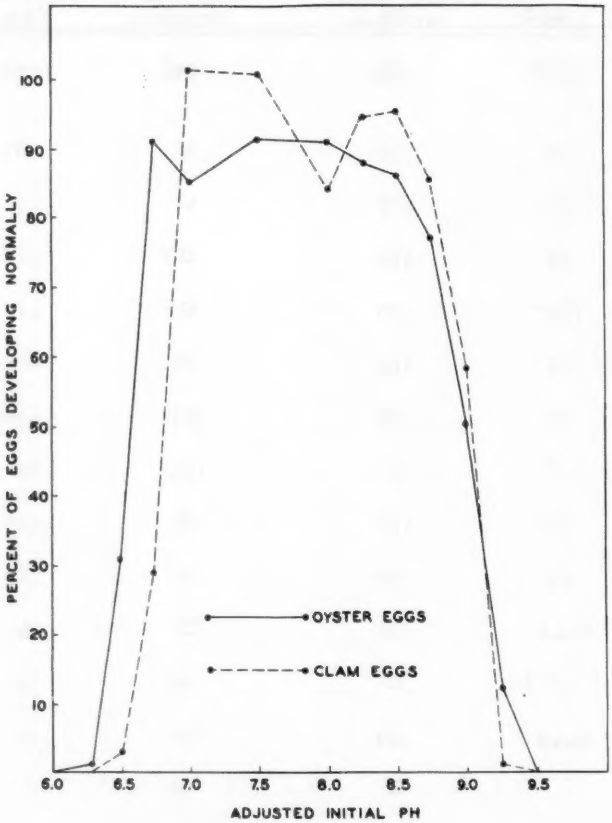

Fig. 1 - Percentage of clam and oyster eggs that developed into normal straight-hinge at different pH levels, expressed as a percentage of the number developing into normal larvae in control cultures /after (4)/.

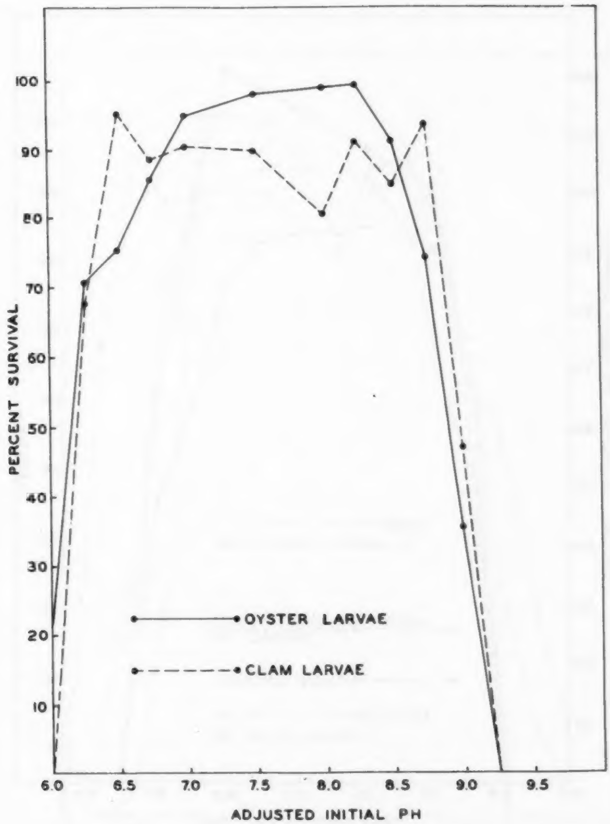

Fig. 2 - Percentage of clam and oyster larvae that survived at different pH levels, expressed as a percentage of survival in control cultures [after (4)].

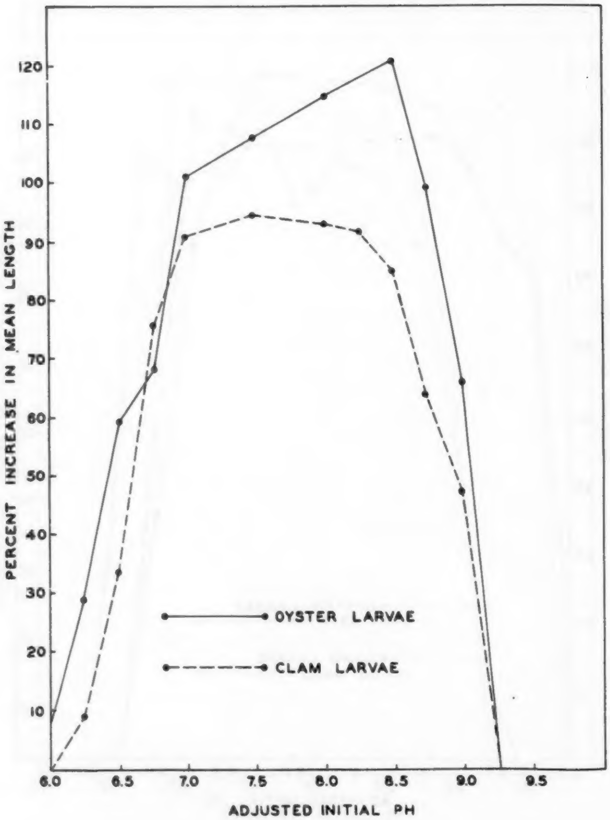

Fig. 3 - Increase in mean length of clam and oyster larvae at different pH levels, expressed as a percentage of the increase in mean length of larvae in control culture /after (4)/.

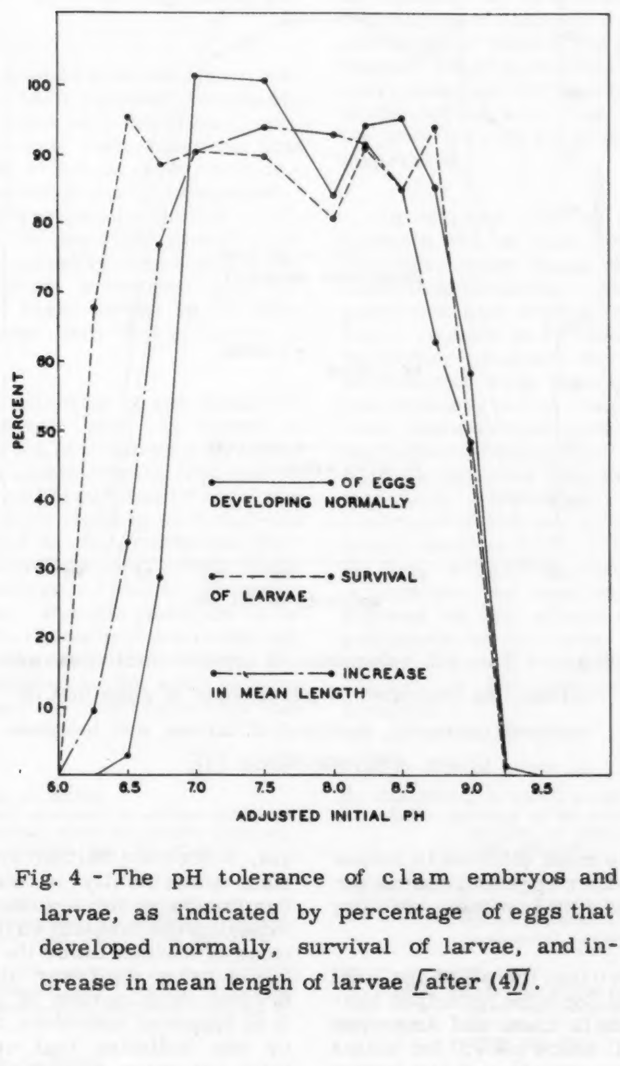

Fig. 4 - The pH tolerance of clam embryos and larvae, as indicated by percentage of eggs that developed normally, survival of larvae, and increase in mean length of larvae [after (4)].

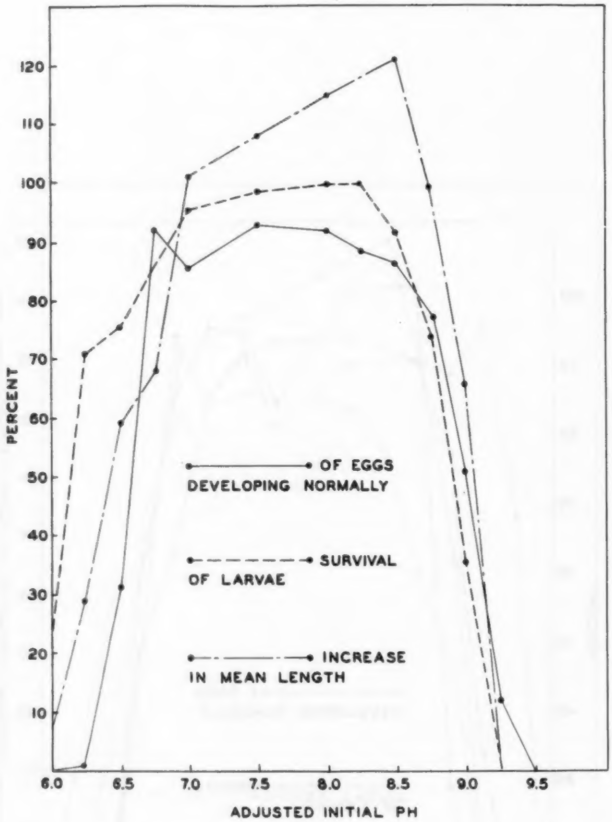

Fig. 5 - The pH tolerance of oyster embryos and larvae, as indicated by percentage of eggs that developed normally, survival of larvae, and increase in mean length of larvae. [after (4)].

and at pH 6.0 it was most difficult to induce females to spawn. Also, eggs and sperm released at pH 6.0 and 10.0 lost their viability within 2 to 4 hours.

It can be concluded that the pH of the tidal estuarine waters that form the principal habitat of the hard-shell clam and American oyster must not fall below pH 7.0 for clams or pH 6.75 for oysters, even though the larvae of both species can survive at lower pH levels. Moreover, neither species could reproduce successfully in waters where the pH remained appreciably above 9.0. Laboratory experiments have shown that high concentrations of silt can lower the pH of sea water to 6.4 or below the lower limit for normal embryonic development of clams and oysters. It is apparent, therefore, that heavy siltation, or any pollution that can change the pH of tidal estuarine waters, could cause failure of recruitment of these clams and oysters.

PESTICIDE STUDIES

Fifty-two compounds were tested for their effects on embryos and larvae of the hard-shell clam and the American oyster, using the procedures described above (6,7). The pesticides included 17 insecticides, 12 herbicides, 1 nematocide, 4 solvents, and 18 miscellaneous bactericides, fungicides, and algicides.

Most of the compounds affected embryonic development more than survival or growth of larvae. Some, however, drastically reduced growth of larvae at concentrations that had relatively little effect on embryonic development. Within each group of compounds, there were great differences in toxicity to bivalve larvae. DDT, for example, at 0.05 ppm caused over 90% mortality of oyster larvae and almost completely prevented growth, whereas growth of clam larvae in 5.0 ppm of lindane was faster than that of larvae in control cultures.

The highest concentration of any pesticide that can be considered "safe" in waters in which valuable species of bibalves reproduce will be the highest concentration that has no appreciable effect on: 1) survival of developing embryos (from fertilized egg to 2-day-old veliger larvae), or 2) on the growth and survival of the fully formed veliger larvae (from 2-day-old feeding larvae to 2-week-old metamorphosing larvae). For the pesticide to be considered "safe" in the natural environment, it would also be necessary to determine the concentrations tolerated by the adult bivalve spawning stock and by the organisms that serve as foods for both larval and adult bivalves.

A distinction is made between developing embryos and the fully formed larvae because, quite often, the tolerance of these two pelagic stages to a given toxicant is markedly different. Moreover, growth of the fully developed larvae may be drastically retarded at concentrations of toxicant too low to cause direct mortality of either embryonic or larval stages. Such a retardation of growth, however, would serve to prolong the pelagic life of the larvae and, thus, increase the chance for loss through predation, disease, and dispersion.

An attempt was made to point out the possible effects that pollution may have on the embryos and larvae of some commercially important mollusks. From the information given one can deduce that in some cases it would require such high concentrations of a particular pollutant to affect bivalve larvae seriously in large bays and estuaries so that pollution may not be a serious problem. However, this may be misleading because, depending on the hydrography of a particular body of water, a pollutant may remain localized and, therefore, concentrated. This would then be a serious problem. In cases of other pollutants, such as DDT, only a small amount in an area will affect recruitment of bivalves. A problem that also would have to be considered is the effect of a combination of pollutants in an area; the interaction of a combination of pollutants may enhance the toxicity of any one particular pollutant to bivalves.

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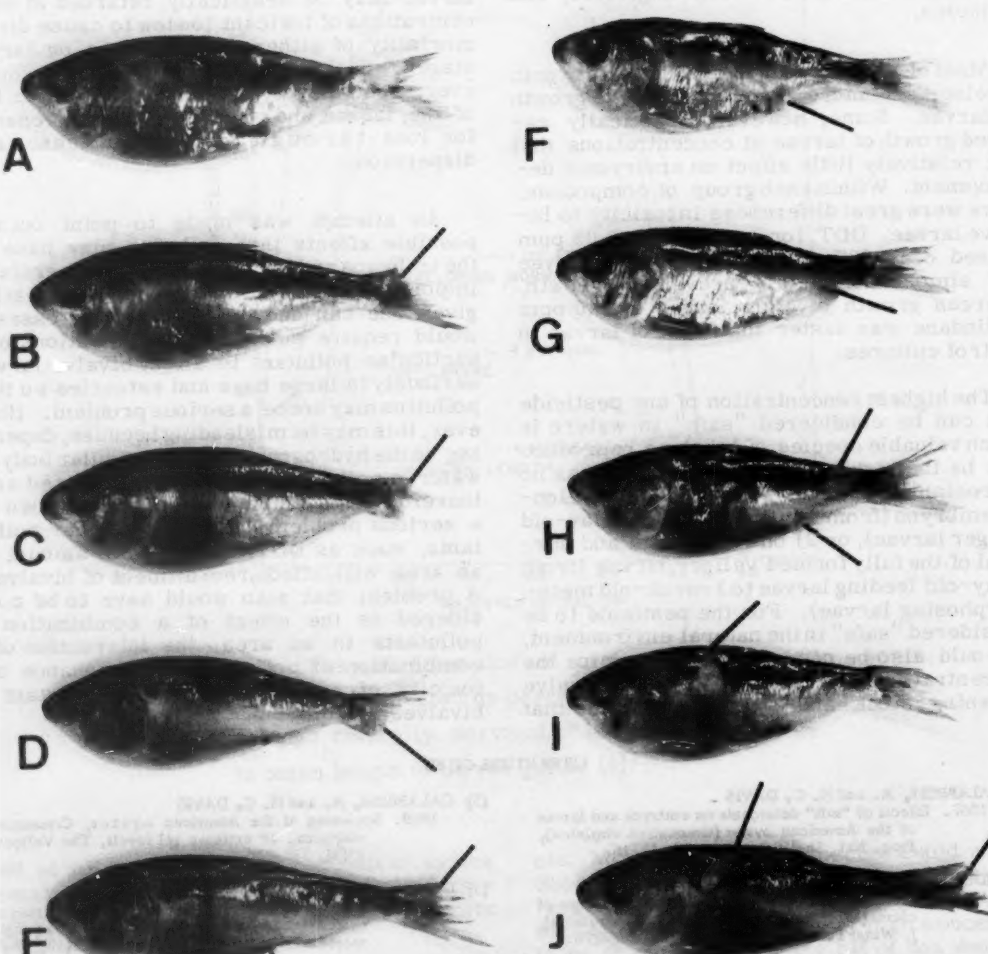

Fig. 1 - Juvenile menhaden injured by predators. Fish A is normal.

EFFECT OF PREDATORS ON JUVENILE MENHADEN IN CLEAR & TURBID ESTUARIES

Richard L. Kroger and James F. Guthrie

Little is known about the effects of predation on juvenile menhaden during their 6 to 9 months of estuarine life (Reintjes and Pacheco, 1966). Numerous published reports have described the occurrence of juvenile menhaden in stomach samples of other species (Reintjes, Christmas and Collins, 1960). No studies have mentioned scarring rates in populations of juvenile menhaden from different-type estuaries, or the kind of injuries incurred by juveniles that escape after being bitten by predators.

A sample of 682 juvenile Gulf menhaden, Brevoortia patronus (mean fork length 62 mm), a spotted sea trout, Cynoscion nebulosus, and a blue runner, Caranx crysos, were collected in Steinhatchee River, Florida, on July 13, 1971, with a cast net. We examined the menhaden immediately and determined that 19% had been injured by predators. Injuries ranged from single tooth slashes to missing fins and chunks of flesh (Figure 1). It can be assumed that most injuries occurred recently if rapid regeneration and healing obscures injuries in this river, as observed for fin-clipped and tagged juvenile menhaden in other estuaries and in the laboratory (Kroger and Dryfoos, 1972), or if injured menhaden in schools are preyed upon at a greater rate than noninjured menhaden (Gunter and Ward, 1961).

Most injuries were probably caused by trout and other sight-feeding predatory fish, such as blue runners (Simmons and Breuer, 1950 and Reintjes, 1969). We saw these species make 20 predatory attacks in 1 hour on menhaden schools at the surface in a small cove. Water clarity, as indicated by secchi disk readings, registered greater than 100 cm (the length of our secchi stick). We consider this very clear and ideal for sight-feeding predators.

Predators Reduce Schools

Observations by fishermen and rate of scarring suggest that the number of juveniles in Steinhatchee River decreases steadily as a result of predation. Fishermen who live by the river reported that schools of juvenile menhaden are usually 20 to 30 feet in diameter in April. But, by July of each year, the schools which are about the same in number are reduced by the abundant predator population to the 5- to 10-feet-diameter schools we saw. These observations are supported by calculations--based on the fact that 19% of the fish were injured, and the assumption that one of 10 bitten juveniles survives. These indicate that our sample of 682 fish was the remains of an original group of 1,852 juveniles ($682 \times .19 \div .1 + 552 = 1852$). This estimate should be greater if scars disappear, or if rate of predation increases on injured menhaden.

The precise number of injured juvenile menhaden in samples from other clear-water and turbid estuaries was not obtained because we did not immediately examine each fish when fresh. After the samples were preserved, only major injuries were discernible. Based on field calculations, however, we know that at least 10% of the juvenile Atlantic menhaden, B. tyrannus, were injured in samples collected from two Rhode Island and Massachusetts clear-water estuaries in 1969-71. Water clarity in these estuaries was such that the bottom was visible in over 2 m of water. Typical abundant predatory fish captured in the haul seine with the injured menhaden, and whose stomachs contained menhaden, included chub mackerel, Scomber colias, and bluefish, Pomatomus saltatrix. Other probable menhaden predators were caught, but their stomachs were not examined; these included crevalle jack, Caranx hippos, and northern sennet, Sphyraena borealis.

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Contrast of Turbid Estuaries

In contrast, while capturing juvenile menhaden for tagging and yearly abundance studies from 1956 to 1971 on the Atlantic and Gulf coasts, we have never observed more than one or two injured juvenile menhaden in any of several thousand samples collected in over 50 turbid estuaries where secchi readings ranged from 10 to 50 cm. Stomachs of ladyfish, Elops saurus, captured in these samples have been examined and shown to contain a high percentage of juvenile menhaden (Sekavec, 1971). The only other typical predatory fish captured with the juveniles in these turbid estuaries, and which stomach analysis showed they fed on menhaden, included longnose and alligator gars, Lepisosteus osseus and L. spatula. These turbid-water predators usually were absent from the samples, or were present only in small numbers.

The high rate of scarring we observed in populations of juvenile menhaden in clear water, relative to turbid water, indicates either a different rate of escapement when juveniles are bitten by the resident predators--or a different rate of predation on the juveniles in the two types of estuaries. We believe the great amount of scarring indicates a higher rate of predation on the menhaden. In our opinion, abundant predators severely reduce the number of juvenile menhaden in some clear-water estuaries, whereas in turbid estuaries rates of predation on menhaden are much lower (Kroger and Guthrie, 1973). Additional studies of the interaction of menhaden and predator populations in clear and turbid estuaries are needed.

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JAPAN

1971 MARINE FISHERIES CATCH SET RECORD

The Japanese catch in marine fisheries during January-December 1971 reached a record 9,135,000 metric tons, up 538,000 tons, or 6%, over 1970. This was reported by the Statistics and Survey Division, Ministry of Agriculture and Forestry.

The predominant catches were Alaska pollock, 2.7 million tons, and Pacific mackerel, 1.25 million tons; both species combined were 40% of total. Other substantial increases over 1970 were sardine, sandlance, saury, salmon, bluefin tuna, and albacore; decreases were notably large for squid and skipjack, among others. ('Suisan Tsushin', Oct. 21, 1972.)

* * *

GOVERNMENT'S NEW TRADE CONTROL AFFECTS FISHERY EXPORTS

To meet the problems that may result from yen revaluation, the Japanese Government has adopted an ordinance controlling exports. The Ministry of International Trade and Industry (MITI) began to implement the ordinance on Dec. 7, 1972.

Products subject to export control include those that exceeded US$100 million during August 1971-July 1972. Fresh and frozen fishery exports totaled about $120 million. Coming under control are 18 fish species. These include tuna (skipjack, albacore, yellowfin, bluefin, and others), swordfish fillets and steaks, sailfish, sea bream, yellowtail, Pacific mackerel, saury, salmon, shark, rainbow trout and goldfish, and others. The export ceiling (in value) for each species has been set at the value exported during August 1971-July 1972, plus 52.6%; exports over that will be prohibited.

Industry Fears Controls

The fishing industry fears trade control will seriously affect exports. On Nov. 9, 1972, 10 major groups petitioned the Fisheries Agency, MITI, and other agencies to exempt fishery products. They said the restriction would be very bad for exports of frozen Greenland turbot and Alaska pollock fillets; these recorded rapid gains only recently. ('Nihon Suisan Shimbun', Nov 13; 'Suisan Keizai Shimbun', Nov. 3, 1972.)

* * *

WILL SEVERED JAPAN-TAIWAN DIPLOMATIC TIES AFFECT FISHING INDUSTRY?

The resumption of diplomatic relations between Japan and China opens an era of friendship--political, economic, and cultural. Before, Sino-Japanese trade was conducted privately on a limited scale; now it will be greatly expanded. However, this development has cut the close friendly ties between Japan and Taiwan and ended the bilateral trade agreement. Taiwan trades heavily with Japan. Either she may take economic reprisals against Japan and promote greater trade with other nations, or she may continue exports to Japan on a private basis but reduce imports.

Japan-Taiwan Fishery Links

In the fisheries, unlike other industries, Japan's ties with Taiwan have been closer in technical cooperation than in investments. Cooperation produced a vigorous trade. In 1971, Japanese fishery exports to Taiwan reached 22,870 metric tons worth 2 billion yen (US$6.67 million); imports recorded 29,000 tons worth 13.3 billion yen ($44.3 million). Exports to Taiwan are mainly fish oil, canned fish, and salted, dried, or smoked products; imports are mostly live young eels for culture, shrimp, and tuna.

The fishery trade has continued favorably, particularly for Taiwan. If it is halted or reduced, Taiwan's economy would be hurt. The outlook for the fishery trade is that it will be reduced.

Fishing Safety Involved

The termination of diplomatic relations presents a problem involving safe operation of Japanese vessels fishing off Taiwan and the nearby islands claimed by it, such as Senkaku Island. One vessel was seized recently by Taiwanese authorities. Similar seizures can be expected, particularly if

JAPAN (Contd.):

Taiwan extends its territorial sea limits from the present 3 miles. ('Suisan Keizai Shimbun', Oct. 10, 1972.)

* * *

TUNA FEDERATION LAUNCHES MEDICAL AND SUPPLY SHIP

A 2,990-gross-ton medical and supply ship, 'Japan Tuna', was launched Oct. 21, 1972. It was ordered by the Federation of Japan Tuna Fisheries Cooperative Associations (NIKKATSUREN). It will be used to provide medical service, fuel, and provisions to about 200 members vessels longlining in the eastern Pacific. (Note: In Japan, the eastern Pacific generally includes the area east of 130^{o}W. longitude, which runs near the Marquesas Island.)

Medical Facilities

The 'Japan Tuna' will cost 400 million yen (US$1.3 million), including a 30-million-yen ($100,000) government subsidy for medical facilities: separate rooms for examination, X-ray, and surgery.

NIKKATSUREN, which began high-seas refueling in 1963, previously used chartered tankers for that service. ('Suisan Keizai Shimbun', Oct. 25, 1972.)

* * *

FISHERY TEAM TO SURVEY ALASKA IN SUMMER 1973

Japan will send a fishery team to Alaska in July or August 1973 to survey the coastal resources. The project results from a proposal for a joint survey reportedly agreed to by Governor Egan and a visiting Japanese economic mission.

The Japanese will present their proposal to Alaska. Under study is a plan to send 10 men to survey primarily kelp, abalone, and sea-urchin resources jointly with Alaskans. The Alaskans hope the survey will contribute to the state's economic growth. ('Suisan Keizai Shimbun', Nov. 8, 1972.)

* * *

TAIYO IS BUILDING COLD STORAGE IN CUBA

Taiyo Gyogyo is building a 10,000-ton-capacity cold storage at Santiago de Cuba for the Fisheries Ministry. Cost is 1 billion yen (US$3.3 million). Construction was begun in September 1971 and is scheduled for competion in mid-December 1972. It is being handled through Ataka Industries. Cuba's operation of the cold storage will result in greater fish trade with Taiyo, which already is buying shrimp.

Taiyo is planning to build another 10,000-ton cold storage for the Construction Ministry for vegetables and bananas; it is negotiating to build a third plant.

The firm also is reported to have been approached by the Cuban Government to construct a canning plant and a shipyard capable of building 1,000-2,000-ton ships. ('Suisan Keizai Shimbun', Nov. 11, 1972.)

* * *

MORE SHRIMP TRAWLERS APPROVED FOR GUIANAS

In late October 1972, the Fisheries Agency tentatively approved the entry of 52 more vessels into the shrimp fishery off the Guianas. At present, seven firms are operating 70 shrimp trawlers there out of Georgetown (Guyana), Paramaribo (Surinam), and Port of Spain (Trinidad).

Of the 52 vessels, 21 will be licensed for operation by the 7 shrimping firms; these firms are building a 500-ton-capacity cold storage in Paramaribo jointly with local interests. Thirty-one will be licensed to vessel owners forced out of the North Pacific salmon fishery, Isei (East China Sea) trawl fishery, and the sea bream longline fishery off New Zealand. ('Suisan Keizai Shimbun', Nov. 14, 1972.)

KRILL FISHING EXPEDITION TO ANTARCTIC OCEAN

The 'Chiyoda Maru' (2,000 gross tons) departed Tokyo Oct. 27, 1972, on a krill fishing expedition to the Antarctic Ocean. It was chartered by the semigovernment Marine Fishery Resource Development Center.

JAPAN (Contd.):

The vessel was scheduled to operate for about two months in the region from the pack-ice line to the Weddell Sea. Production target was 1,000 tons: 800 tons would be frozen fresh, 200 tons would be cooked and frozen. Also, krill extracts would be produced experimentally.

Itinerary

Enroute, the vessel was slated to call at Valpariso, Chile, December 2-3, 1972, and will commence operations on December 11 near 55°S. latitude and 60°W. longitude. Operations will end Feb. 9, 1973. Return to Japan is scheduled for March 19 with a stop-over at Durban, South Africa, on Feb. 15, 1973. Gear used include 3-4 meter "waku-ami" (framed nets), fish pump, seine net, and attractant lights.

The Japanese previously had conducted three experimental krill fishing trips to the Antarctic. The Soviets are said to have taken about 2,300 tons in 1971. An FAO study estimates krill abundance at 300-500 million tons. ('Suisan Keizai Shimbun', Oct. 30, 'Minato Shimbun', Oct. 26, 1972.)

* * *

BUY TUNA FROM THE PHILIPPINES

The Japanese refrigerated carrier 'Filipina Maru' (350 gross tons) returned recently to Yaizu with 45 metric tons of yellowfin and bigeye bought from Filipino fishermen. The vessel was sent to the Philippines in July this year. Its crew spent 3 months buying tuna from natives fishing in 3-5-man canoes in the Sula Sea from bases in southern Mindanao Island and Zamboanga.

Cash to Fishermen's Agent

Cash payment was made to the fishermen through a representative of the canoe operators. Although some U.S. tuna packers and Japanese trading firms are said to be buying tuna from the Philippine canoe fishermen, this is the first time that a Japanese vessel has been sent there to buy tuna. The owners of the 'Filipina Maru' hope to continue this operation. ('Suisan Keizai Shimbun', Nov. 3, 1972.)

S. KOREA'S MARINE-PRODUCTS CANNING INDUSTRY GROWS

S. Korea's canning industry is small but important to its economy. Between 1967 and 1971, the value of all canned foodstuffs increased from US$7.2 million to $14.6 million. Exports of canned goods (primarily mushrooms and oysters) increased in value from $1.1 million to $7.7 million.

Production of canned marine products increased from 4,957 metric tons in 1967 to 6,695 tons in 1970 and jumped to 23,703 tons in 1971. The Office of Fisheries said canned oyster production of 10,116 tons (landings were 54,000 tons), led this increase. Very few people eat canned oysters in S. Korea; practically the entire production is exported. In 1971, these exports were worth $1.4 million ($140,000 in 1970, $36,000 in 1969); they accounted for 18% of value of canned-food exports and 75% of export of canned marine products.

Smoked and Boiled Oysters

The oyster exports were almost equally divided between smoked and boiled. The U.S., principal market, imported $1.3 million in 1971; as of June 1972, the figure was $2 million. Saury, mackerel, squid, and other shellfish also are canned for export and domestic consumption.

Bright Industry Future

The canning industry expects a bright future. Raw materials, such as oysters, are readily available. Low labor costs and streamlined export procedures make the S. Korean products highly competitive. Therefore, exports of canned products are expected to increase rapidly in the next few years.

The industry also expects to increase domestic trade. Until recently, canned foods were not popular. However, the rise of a middle class has resulted in growing acceptance of canned products. Domestic consumption decreased in 1971 due to a poor business year and increased export promotion. But industry leaders expect the domestic market to improve. (U.S. Embassy, Seoul, Sept. 20, 1972.)

NICARAGUA OFFERS SOME INVESTMENT OPPORTUNITY

Nicaragua has limited to 100 the number of shrimp boats licensed to fish on the Atlantic coast. This limit will be increased to 108 to accommodate eight already purchased boats. However, no further increases on the Atlantic are foreseen.

Only 38 shrimp boats are operating on the Pacific Coast, though 103 are authorized. Another dozen boats might be accommodated on the Pacific side, the government says, but further growth would affect sound conservation practice.

Best Opportunities

The best opportunities for new investment appear to lie in species other than shrimp and lobster. Finfish are almost entirely untapped. Except for the almost incidental catches by shrimpers, most other fishing is traditional rather than commercial, characterized by inshore handlining from small boats. No studies have been made and little practical fishing done, so the quantities of fish available are still unknown.

Oysters & Lobsters Good Bets

Industry sources believe oysters and scallops also are good bets for investment and exploitation. Large beds of "midget" oysters are known and could be harvested immediately. However, dredging to spread the oyster beds and allow stunted oysters room to grow to a more marketable size probably would be more profitable. The problem remains of satisfying U.S. Food and Drug Administration requirements for importing molluscan shellfish into the U.S.

Shrimp Catch Rising

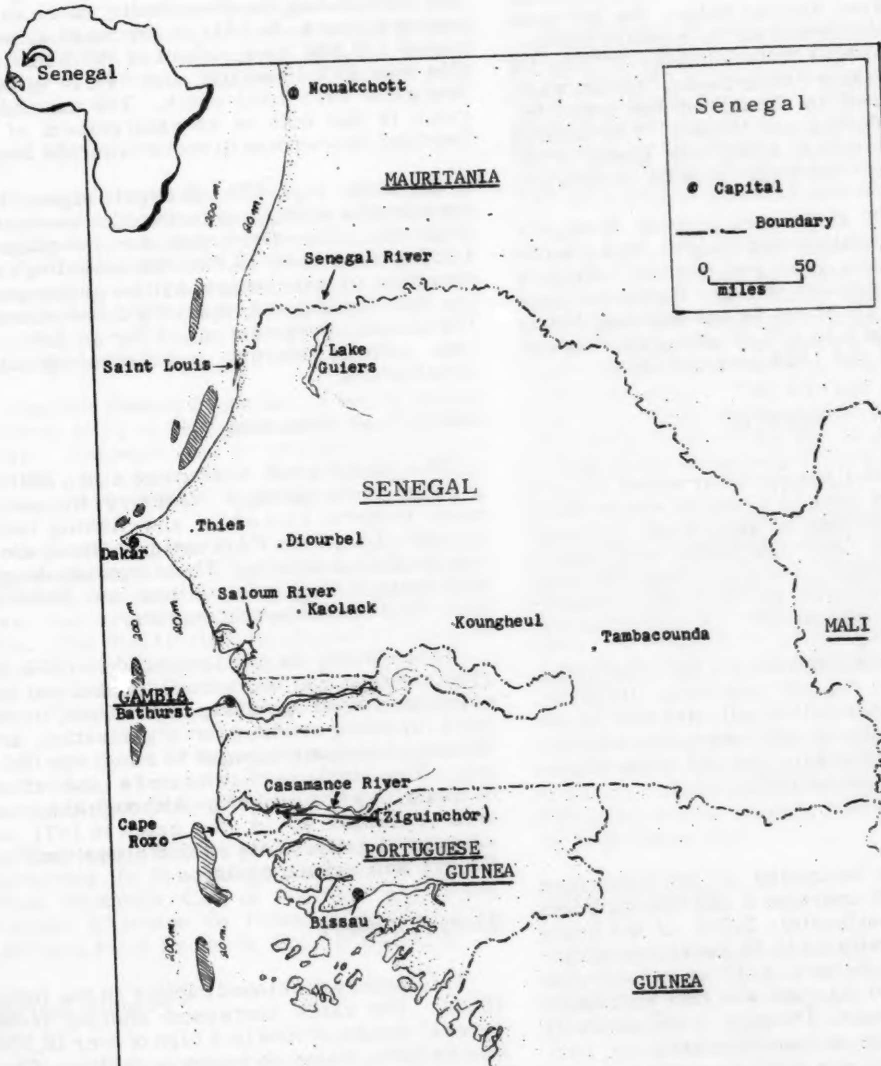
Nicaragua's shrimp catch is on the upward swing of its normal cycle. It reached 4.3 million pounds for first-half 1972, compared to 2.96 million pounds for first-half 1971. Over the next several years, both shrimp and lobster production should increase steadily. Three factors are involved in this projected growth: 1) more boats will be operating off Pacific coast; 2) in 1971, Nicaragua established protection for shrimp-breeding grounds in lagoons and river mouths of Atlantic coast by prohibiting all shrimping there. Finally, most Pacific shrimpers are working the shallow and medium depths that hold white shrimp. By adding larger-capacity winches, boats also will be able to fish for red shrimp at greater depths and increase total catch 20%.

Lobster Trapping

Lobster trapping should become more productive over the next several years. There is some concern that this easily overfished species might be damaged by unrestricted industry growth. This is a long-term problem, and no restrictive legislation is being considered.

Unrestricted Exports to U.S.

There are no restrictions affecting exports to the U.S. On the contrary, due to growing demand and excellent prices, the U.S. will continue as Nicaragua's best market for seafood, especially shrimp and lobster. (U.S. Embassy, Managua, Sept. 25,1972.)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Koungheul
Tambacounda
MALI
GAMBIA
Bathurst
Casamance River
(Ziguinchor)
Cape Roxo
PORTUGUESE GUINEA
Bissau
GUINEA
Shrimp fishing grounds.

THE FISHERIES OF SENEGAL: 1971

William B. Folsom & R. E. Neumann

The Republic of Senegal, roughly 76,000 square miles (about the size of South Dakota), lies on the West African bulge. Its 300-mile Atlantic coastline marks its western border, while the Senegal River divides it from its northern neighbor, Mauritania. On the east, it is bordered by Mali; on the south by Guinea and Portuguese Guinea. The Gambia extends 200 miles along the banks of the Gambia River into the middle of Senegal.

The 30,000 fishermen provide Senegal's 3,840,000 population with roughly 30.6 pounds of seafood each year per person--Africa's foremost consumers of fish. Fisheries contribute about 3% of the Gross National Product (GNP), and 8 to 11% of total export earnings for 1967 and 1968, respectively.

CATCH

In 1971, the fishermen harvested 221,828 metric tons of fishery products worth US$45 million. This was a significant increase over the 1970 catch and value, and almost double the quantity and four times the value of the 1960 catch. In 1960 this French-speaking country gained its independence.

Complete information on the 1971 catch, by species, is not yet available. However, preliminary information indicates that 43,000 tons of sardinella, 15,900 tons of sea breams, 4,600 tons of shrimp, and 133 tons of lobsters were caught in 1971.

Canoe Fishery

In 1971, an estimated 27,960 fishermen (27,131 in 1970) operated 5,293 fishing boats (canoes and sailboats); 2,578 of the boats were equipped with 10 to 25 horsepower outboard motors. Generally, these vessels are crewed by two to six men who fish with handlines or small nets. The bulk of the catch is sold unprocessed on local markets.

"Pirogue" fishing (in dugout canoe or boat like canoe) has caught steadily more in the past few years. In 1971, it produced an estimated 178,883 tons valued at $28.6 million; this was 80% in weight and 64% in value of Senegal's 1971 total catch. The increasing catch is due both to an enlargement of the fleet and to progress in motorizing the boats.

On July 12, 1972, Senegal signed two agreements with Canada to help develop its fisheries. The first was for purchase of 3,500 motors worth $2,720,000, including construction of warehouses and shops for storing, distributing, and repairing these motors. The second agreement called for an $880,000 loan, without interest, to build refrigerated installations.

Small-Craft Fisheries

The small-craft fisheries are distinguished from pirogue fisheries by use of more modern vessels and fishing techniques. Based on FAO designs, the vessels are produced locally. Their average length is 13 meters, weight 6 to 8 tons, and powered by 65 to 70 horsepower engines.

This fishery began to expand in 1964; by 1966, the fleet had more than doubled and the catch increased by nearly 50%. Then, problems involving credit, poor organization, and ill-suited equipment began to affect the fishery. The number of vessels and catch dropped to a low in 1970. Although the vessels remained at 14, the catch in 1971 increased slightly. This raised hopes that the fishery will expand again.

Sardine Fishery

This fishery developed rapidly in the mid-1960s. The catch increased sharply from several thousand tons to a high of over 18,000 tons in 1969. Later, it began to decline. The

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number of vessels has remained constant--4 Senegalese and 1 French-owned vessel--but their equipment is now wearing out. Senegal believes that the sardine resource has suffered from foreign exploitation. Nevertheless, due to increased world prices, the value of sardine catch has increased slightly from $1.1 million in 1970 to $1.2 million in 1971.

Trawl Fishery

In contrast to small-craft and sardine fisheries, the trawl fishery has increased steadily in vessels and production. In 1971, the fleet reached 83 (58 French-owned, 11 Senegalese, and 14 others); their total catch exceeded 10,000 tons for first time.

Tuna Fishery

The tuna fishery continues to be the major success story of Senegal's commercial fisheries. Although only 47 vessels fished tuna in 1971, four fewer than in 1970, their catch increased by 54% to 18,461 metric tons.

Of particular interest is the record of the Societe Senegalaise d'Armement a la Peche (SOSAP), a mixed industry/government venture, compared to catch by French tuna vessels. The SOSAP fleet numbered 17 vessels in 1971 (only 15 fished due to late delivery of two boats from Germany). It caught slightly over 50% more than the 30 French vessels.

Virtually all of Senegal's tuna is exported to France, where a special quota agreement brings higher prices than world prices.

The tuna catch is processed by the Conserveries du Senegal Alimentaires (African Food Products Co., or SAPAL) and by the Societe Africaine de Produits Alimentaires (African Food Products Co., or SAPAL).

Shrimp Fishery

Senegal's most promising fishery is shrimp. Production increased from 124 tons in 1960 to 600 tons in 1966, when marine shrimping began, and to 4,599 tons in 1971.

Estuarine Fishery

The commercial fishery is based on young, estuarine shrimp--pink shrimp (Penaeus durarum, called "la grosse" or la blanche" in Senegal). It began in 1959 when a plant was built on the Casamance River in southern Senegal.

The fishery is very simple. Between May and August, 800 to 1,000 fishermen operate in an area 40 kilometers up river from the town of Ziguinchor. Each fisherman has an anchorage on the river. A 12-mm mesh net held open by two beams is placed across the current, slightly above or below the surface. The net is held in place by two dugout canoes.

At night, when the tide is running, the dugouts are towed to their anchorages by plant owners. The owners also lend fishing materials. When the tide changes, each fisherman brings his net ashore and sells his catch to the plant owners, who collect the shrimp in trucks. The average catch per net runs from 5 to 10 kilograms per day, but it can reach 30 to 40 kg/day in good locations during height of season (May to July).

There are several shrimp-processing plants along Casamance River. Most of their production is trucked to Dakar for export to Europe (mainly France). The largest plant is at Ziguinchor--the Amerger-Casamance plant. It is new, well managed, and has one operation which brine-freezes cooked whole shrimp.

The Casamance fishery could be expanded considerably, but lack of roads downstream prevents collection of shrimp catches. Outside Casamance region, there are no major shrimp resources.

Marine Fishery

Shrimping at sea was begun on an exploratory basis in 1963. In 1965, five vessels fished; by 1966, 16 vessels. These were old side-trawlers rigged for twin-trawling. In 1968, many were replaced by modern vessels. Between 1966 and 1968, the shrimp catch increased from 195 tons to 2,142 tons. Presently, the trawl fleet takes over three-fourths of the total shrimp catch (4,599 tons in 1971).

There are two major trawl shrimping grounds: in the north, a 350-square-mile area extending from Cayar Canyon to north of St. Louis (fishing from November to

April). The second area is off Gambia River, a narrow stretch of mud 450 squares miles long between mouth of Casamance River and Bissagos Islands. Production is usually good between August and November.

Deepwater shrimp (Penaeus longirontris) are taken on continental slope (200 to 400 fathoms), mostly by Spanish and others.

DOMESTIC & FOREIGN DEVELOPMENTS

Port Development

Development of Dakar's fishing facilities has been consistent, if not rapid, over the past 10 years. The Government has been developing the ports while relying on private capital, foreign or domestic, to provide freezing and processing plants. The two main projects of the Third Plan, now largely completed--construction of a large $1.5 million fishing pier and deepening of port's fishery portion by six meters--should aid fisheries.

Foreign Participation

Most foreign investment involves European (mainly French) participation. However, a U.S. firm and, more recently, a Kuwait-based firm have invested.

Star-Kist, a large U.S. firm, has a 32.5% interest in Societe de Frigorifiques du Senegal (SOFRIGAL), a freezing and storage operation. The latter neither cans nor fishes for itself. Its plant is equipped with brine-type freezing tanks. It has a freezing capacity of 100 metric tons per 24 hours. There are four cold-storage rooms with a total capacity of 2,000 tons. Two ice machines produce a total of 35 tons of flake ice per day, used primarily by local boats.

Another foreign investor is Gulf Fisheries company of Kuwait. It has 24 vessels based in Dakar. It is the largest shrimping operation in Senegal. The vessels are identical small trawlers built in France. Operations began in 1970.

The trawlers freeze their catch onboard. Each vessel has a 50-ton storage capacity. Previously, the shrimp were retained onboard until transshipped for export. The company now has leased cold-storage facilities.

Senegal encourages foreign investment with the possibility of 5-year "tax holidays," duty-free import of materials, and easy capital repatriation.

New Legislation

Senegal claims territorial waters of 12 miles. She believes foreign fishing outside these limits has severely affected local catch. In April 1972, the National Assembly passed a law establishing a fishing zone 110 miles beyond the 12-mile territorial sea. This law, signed by the President in July, provides that foreign companies may fish within these waters if they reach agreement with the Government.

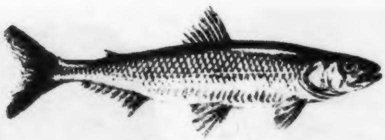
The French are not affected because they have an agreement permitting them to fish within territorial sea. On June 1, 1972, Senegal signed an agreement with Spain. The latter will help in fishery research, train fishermen, and land part of their catch in exchange for fishing rights. Reportedly, the Norwegians and Japanese are actively negotiating for similar agreements.

TRADE

Senegal has made progress in recent years in exporting fishery products. Most go to Europe and African countries. The development of processing industries remains the weakest part of Senegal's attempt to develop its fishing resources, among the most valuable along the West African coast.

Senegal continues to import sizable amounts of fresh, chilled or frozen fishery products. These imports, however, are valued below their total fishery exports. This provides the industry with a favorable balance of trade.

FOOD FISH FACTS



Smelt
(Osmerus mordax)

Smelt have been a popular food fish on the North American continent for hundreds of years. Captain John Smith reported, on one of his explorations of the New England area in 1622, that the smelt were so abundant that local Indians scooped them out of the water in baskets. Among early Pacific slope Indians, fish were extremely important as food and used as one of the chief items of trade. Pacific Indians enjoyed smelt as a food and also utilized one particularly oily variety by drying the fish and burning it as a candle. Today, smelt are still considered one of the finest food fishes. Smelt takes its name from the ancient Anglo-Saxon word "smoelt" meaning smooth and shining. Local names for smelt include icefish, frostfish, and candlelight fish.

Description

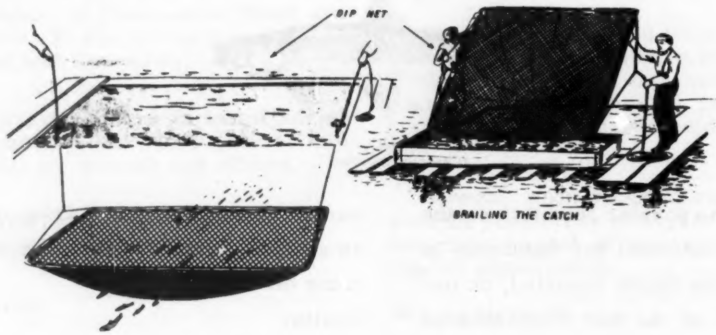
Smelt resemble midget salmon in appearance and they are distantly related to the salmon family. The smelt is a small, slender, silvery fish with olive green coloring along the back. The average size of smelt varies from 7 to 8 inches, occasionally up to 14 inches. The average weight is from 10 to 11 smelt to the pound and up to $\frac{1}{2}$ pound each for some of the larger ones. Smelt have a large mouth for their size and the lower jaw projects beyond the upper. The tip of the tongue has large, fang-like teeth which, with the large mouth, distinguish smelt from other similar small fish. Smelt have large scales which come off readily.

Habitat

Originally anadromous, like their relatives that live in the ocean and ascend rivers and streams to spawn, smelt have adapted to fresh-water habitats, living in cold-water lakes and streams in many parts of the United States. The Columbia River with its tributaries in the West, the Gulf of St. Lawrence to the Virginia Capes in the East, and the Great Lakes area in the Midwest are all smelt country. Smelt were first introduced into the Great Lakes area in 1906, primarily to provide food for salmon which were being planted in Michigan lakes. The salmon transplantation failed, at that time, while that of the smelt succeeded beyond the wildest expectations of those who carried out the project. It is believed that all of the smelt now found in the Great Lakes came from the eggs taken from Green Lake, Maine, in 1906 and planted in Crystal Lake, Michigan.

Smelt Fishing

In the early part of the year when the ice begins to break, the smelt, traveling mostly after dark, leave the large lakes and rivers and swarm into tributaries on their springtime spawning runs. This is the signal for



hundreds of men, women, and children who splash through the icy shallows to catch the tasty little fish. Their fishing gear varies from nets and buckets to window screens and an occasional bird cage. Anything that can be used to scoop the smelt out of the water is used. The silvery bodies of the smelt darken the waters making them easy prey for sport and commercial fishermen alike. Various types of gear are used by commercial fishermen but the most popular are the pound nets, gill nets, and a modification of the shrimp trawl. In some areas of the United States, smelt are harvested by commercial fishermen throughout most of the year.

Conservation

Most conservation methods which concern smelt are carried out at state levels. Regulations have been set up as to type of gear that may be used as well as the amount of smelt that can be taken. Scientists are seeking answers to fluctuations of smelt abundance as well as why the fishery has declined in some areas. The life histories and spawning habits of smelt are also being studied.

Uses of Smelt

Smelt have delicate, sweet flavor and contain a pleasant oil that aids digestion. Many gourmets consider them one of the choicest of fish. Smelt may be broiled, pan-fried, or deep-fat fried. In some areas, smelt are baked or prepared in a casserole. They are available either fresh or frozen all year round. (National Marketing Services Office, NMFS, NOAA, U.S. Dept. of Commerce, 100 E. Ohio St., Rm. 526, Chicago, Ill. 60611.)

SING A SONG OF SEAFOODS AT BREAKFAST TIME

How do you start the morning? If you or your family wake up grouching instead of singing, you're probably not taking time for a satisfying, nourishing breakfast. It's so easy to start the day with a bounce and have energy that lasts well into the morning--enjoy seafoods for breakfast or brunch.

Fishery products are power-packed with valuable protein and other nutrients and are quickly prepared and cooked. Canned varieties such as versatile, shelf-ready tuna make hearty fare for the first meal of the day. French Toasted Tuna Sandwiches, a new breakfast or brunch idea from the National Marine Fisheries Service, is sure to produce an eager, smiling family waiting in line as you take the savory sandwiches off the griddle. Extra time can be saved by preparing and refrigerating the tasty tuna mixture the night before. All you need to do in the morning is make the sandwiches, dip them in an egg mixture, and fry until hot and golden brown. Serve this novel, nourishing sandwich topped with tart-sweet applesauce for a new taste delight.

Looking for more bright breakfast ideas that save time and produce smiles as well as energy? Send for Top O' The Mornin' With Fish And Shellfish (I 49.39.15), Test Kitchen Series No. 15. This full-color booklet is filled with quick-to-fix, delightful-to-eat, seafood for breakfast ideas. It can be yours by sending 25¢ to the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

FRENCH TOASTED TUNA SANDWICHES

- 1 can ($9\frac{1}{4}$ ounce) tuna, drained
- $\frac{3}{4}$ cup finely chopped celery
- $\frac{1}{2}$ cup salad dressing or mayonnaise
- 2 tablespoons chopped green pepper
- 2 tablespoons chopped pimiento
- 1 teaspoon grated orange or lemon rind (optional)
- $\frac{1}{2}$ teaspoon salt
- 12 slices white bread
- $\frac{1}{2}$ cup milk
- 2 eggs
- 1 teaspoon sugar
- Cooking oil or shortening
- Applesauce, heated

Flake tuna. Combine tuna, celery, salad dressing or mayonnaise, green pepper, pimiento, orange or lemon rind, if used, and $\frac{1}{4}$ teaspoon salt; mix well. Spread 6 slices of bread with an equal amount of tuna mixture; cover with remaining 6 slices of bread. Combine milk, eggs, sugar, and remaining $\frac{1}{4}$ teaspoon salt; beat well. Dip sandwiches into egg mixture. Fry in hot oil or shortening over moderate heat until brown on one side. Turn carefully; brown on second side. Serve with heated applesauce. Makes 6 servings.

(Source: National Marine Fisheries Service, National Oceanic & Atmospheric Administration, U. S. Department of Commerce, 100 East Ohio Street, Room 526, Chicago, Illinois 60611.)

SWEET 'N' SOUR 'N' SAUCY SEAFOOD

Company's coming and you're wondering what to serve? Use your imagination. Company meals don't have to be expensive in order to please. Camaraderie, good conversation, and down-to-the-sea good food will make a meal a success. Using fishery products is being smart in a number of ways--they provide excellent nutrition and great taste. They are easily prepared and quickly cooked. Many fishery products are easy on the budget.

You'll please with versatile flounder or sole fillets. These thin, firm, white fillets have long been favorites. Their delicate flavor makes them great eating, simply prepared or combined with other foods. Flounder adapts easily to rolling for attractive serving. It is protein-rich, practically boneless, and almost 100% edible. Flounder and sole fillets are interchangeable and available almost everywhere either frozen or fresh.

Flounder fillets take on a festive air in Sweet 'N Sour Saucy Flounder, a bright new recipe from the National Marine Fisheries Service. Elegant but easy. The fillets are simply rolled, butter-coated, and baked until flaky. The final gourmet touch is serving the succulent fish with a sweet-sour sauce flavored with pineapple and lemon juice. Bits of pineapple, thin tomato wedges, and diced green pepper are added to the sauce for color and texture interest. This subtle but satisfying combination of flavors is sure to win acclaim. Put it in your prideworthy collection of favorite recipes to be served often.

SWEET 'N' SOUR SAUCY FLOUNDER

2 pounds flounder fillets, fresh or frozen

$\frac{1}{4}$ cup butter or margarine

1 teaspoon grated lemon rind
1 teaspoon salt

$\frac{2}{3}$ cup sugar

2 tablespoons cornstarch
1 cup pineapple juice

$\frac{1}{2}$ cup lemon juice or cider vinegar
1 can (8 ounce) crushed pineapple, drained
1 cup thin tomato wedges

$\frac{1}{2}$ cup diced green pepper

Pineapple slices for garnish
Lime slices for garnish

Thaw frozen fish. Place 2 tablespoons butter or margarine in shallow 2-quart baking dish. Place in moderate oven, 350° F, to melt. Arrange fish fillets, flat or rolled, in baking dish; turn to coat sides with melted butter or margarine. Sprinkle with lemon rind and $\frac{1}{2}$ teaspoon salt. Bake 25 to 30 minutes or until fish flakes easily when tested with a fork. While fish is cooking prepare sauce. Combine sugar, cornstarch, and remaining $\frac{1}{2}$ teaspoon salt; mix well. Add pineapple juice and lemon juice or vinegar; stir. Cook stirring constantly until sauce is clear and thickened. Fold in drained pineapple, tomato wedges, green pepper, and remaining 2 tablespoons butter or margarine; heat. Serve over fish. Makes 6 servings.

(Source: National Marine Fisheries Service, National Oceanic & Atmospheric Administration, United States Department of Commerce, 100 East Ohio Street, Room 526, Chicago, Illinois 60611.)

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from the

National Marine Fisheries Service